Decision Making across the Life Span:

The Role of Motivation

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ABSTRACT

The starting point of the present research was to link motivational life-span development to decision-making research. A theoretical framework is established that links the assumptions that (a) gains and losses can have asymmetrical impact in decision making; (b) personal goals influence decision making; and (c) personal goals are subject to developmental change, mirroring developmental gains and losses. Building on these assumptions, a motivational prevention-of-loss hypothesis in decision making for older adults was established (Chapter I). Previous research was reviewed but provided an inconclusive picture of age-related differences in decision making (Chapter I). To follow up on potential directions outlined in Chapter I and test the hypothesis, different ways in which an increased sensitivity to losses in decision making could manifest were tested. This thesis used a multi-method approach to investigate the hypothesis that developmental changes in goal orientation could influence differential sensitivities to gains and losses. Differential sensitivity was operationalized as (1) asymmetrical information processing of gain-related (positive) and loss-related (negative) information in decision making compared to other ends of information processing (Chapter II), (2) aversion to risk (i.e., uncertainty about the outcome measured as variance; Chapter III), and (3) differential sensitivity in emotional responding to gains and losses (i.e., physiological reactions in skin conductance and heart rate; Chapter III). Additionally, the age-comparative perspective of young and older adults was broadened to adolescents (Chapter III). In Chapter II, using incidental memory paradigms, younger (18-31 years, Experiment 1: $n = 66$; Experiment 2: $n = 62$) and older adults (60-88 years, Experiment 1: $n = 73$; Experiment 2: $n = 60$) were asked to recall information on two hypothetical travel packages (Experiment 1) or on two hospitals (Experiment 2) containing positive (gain-related), negative (loss-related), and neutral information. To test whether decision-related information processing differs from information processing for other purposes,

participants were assigned either to a choice condition or a control condition. Results showed that older adults remembered more negative information in the decision condition compared to a control condition and compared to younger adults, likely to be associated with prevention of loss when a decision was required. In Chapter III, adolescents' (13-17 years, n = 23), young adults' (18-30 years, n = 42), and older adults' (64-85 years, n = 43) risk taking was measured in a non-hypothetical, non-monetary gamble task. Results indicated that older adults were more risk averse in gambling compared to adolescents and young adults, suggesting more vigilance to potential losses. Furthermore, young and older adults' emotional responses (indexed by heart rate slowing) were stronger in reaction to loss feedback. Conversely, adolescents reacted more strongly to gains. This pattern hints at an increase in emotional reactions to losses compared to gains as people age and is in partial agreement with the overarching hypothesis.

A general discussion addresses, among other issues, the functions of asymmetrical processing of gain-related (positive) and loss-related (negative) information.

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INTRODUCTION

The last time you made a decision might have been when you chose to read this text in this very moment. This was just one out of many decisions you made today. Every day of our lives we make many decisions that affect how we spend our time, money, and other resources. We decide what to eat, with whom to spend our lunch break, what to study, where to live, with whom to spend our lives, and so on. Some of these decisions have only short-term consequences, but others are very significant and have long-term consequences for our lives. Both kinds of decisions require choosing an option or course of action from among a set of alternatives (e.g., Marschner et al., 2005). When a person chooses one of two courses of action, she exerts control over the consequences that hold the potential to shape her future. Therefore, decision making is a very important psychological process because it is ubiquitous and allows us to more effectively navigate through our lives. It is essential to understand if and how the psychological process of decision-making changes across the life span because decision making is vital to everyday functioning. This dissertation aims at contributing to a better understanding of age-related differences in decision making.

The decision-making process is a complex psychological process that requires cognitive as well as motivational mechanisms (e.g., Weber & Johnson, 2009). All of the processes that help form a decision may be subject to developmental change across the life span. Among them, motivational changes may be particularly important because motivation orchestrates other processes and guides behavior (e.g., Brandtstädter, 1998; Freund, 2007; Ford, 1987). Previous research on age-related changes in decision making has largely investigated the impact of cognitive life-span developmental changes on decision making. This dissertation aims to broaden the perspective by incorporating motivational developmental changes. More specifically, the research here focuses on the impact of motivational development on sensitivity toward gains and losses as consequences of decision

making. Thereby, the studies presented in this dissertation serve to bridge decision-making theory, motivational psychology, and life-span development to build a better understanding of age-related changes in decision making across the life span.

Three assumptions based on previous research in these three different fields are relevant to this research topic: (a) gains and losses can have asymmetrical impacts in decision making; (b) personal goals influence decision making; and (c) personal goals are subject to developmental change. In the following sections, I will provide a brief introduction of these assumptions.

Asymmetrical Impacts of Gains and Losses in Decision Making

In diverse areas of psychology, negative experiences have been shown to have greater influence on the individual than positive experiences have (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozin & Royzman, 2001; Vaish, Grossmann, & Woodward, 2008). One assumption this dissertation builds on is that gains and losses can have asymmetrical impacts on decision making. Gains and losses are two categories of consequences of a decision. These categories can be defined in terms of positive or negative changes to a reference point, which is often assumed to be the status quo. That means that the consequence of the choice is either better (gain, positive consequence) or worse (loss, negative consequence) than the situation was at the time the decision was made. In empirical research, these categories can pertain to monetary gains and losses in experimental gambles, gains and losses of other possessions, or positive or negative changes in valence (i.e., feeling better or feeling worse; Brenner, Rottenstreich, Sood, & Bilgin, 2007). With respect to decision making, there are at least two types of findings that suggest that gains and losses have asymmetrical meanings, namely loss aversion in decisions under risk and framing effects. First, classic decision-making findings in young adults show that decision-makers act loss-averse: "Losses loom larger than gains" (Kahneman & Tversky, 1979, p. 279). Another demonstration of asymmetrical effects of gains and losses on decision making provide so-called framing effects

(Tversky & Kahneman, 1981). Whether a choice scenario – otherwise identical – draws attention to gains or losses has a dramatic effect on decision-maker's preferences. For example, a choice scenario framed in terms of potential that 50% of capital will be lost will be evaluated as less attractive than the same scenario framed in terms of the potential for 50% of the capital be won – despite the fact that these are essentially the same outcome. Both types of findings have been suggested to result from the same psychological principle, namely loss aversion. The reason for this is that both types of findings demonstrate that losses, compared to gains, seem to have a larger impact on decisions.

Personal Goals Influence Decision Making

Decisions depend on the decision maker's predictions about future experiences and the evaluation of the different options' outcomes (e.g., Loewenstein & Schkade, 1999; Marschner et al., 2005). Outcomes are most likely evaluated with respect to what decision maker wants to achieve or avoid – one's personal goals (Emmons, 1996). In that vein, the choice process can be conceptualized as a maximization process with respect to the decision maker's goals (Tversky & Kahneman, 1986). Furthermore, goal-orientation can be associated with specific strategic inclinations in decision making (Crowe & Higgins, 1997). Overall, personal goals play a critical role in decision making.

Personal Goals are Subject to Developmental Change

Personal goals change across the adult life span. As cited above, personal goals refer to what a person wants to achieve or avoid (e.g., Emmons, 1996). This definition reflects the distinction that is central to motivation theory – motivation to attain a desired state and motivation to avoid an undesired state. This distinction highlights the valence of the outcome (positive or negative) in terms of what the person finds desirable or undesirable. Moreover, the distinction highlights differential strategies for dealing with different end-states, namely avoiding the negative and

approaching the positive. Therefore, goals can have different directions: They can be directed at gains, maintenance, or the avoidance of loss (Freund & Ebner, 2005). Importantly, this orientation of a goal is subject to developmental change. Goal orientation changes (Freund & Ebner, 2005) in accordance with age-related declines in biological and cognitive resources (e.g., Baltes & Smith, 2003; Baltes, Lindenberger, & Staudinger, 2006). Through the course of adulthood, goal orientation shifts from growth-orientation towards maintaining skills, counteracting losses, and focusing on prevention (Freund, 2006; Freund & Ebner, 2005; Ebner, Freund & Baltes, 2006). The central motivation in young adulthood is to maximize one's potential. Older adults are more motivated to pursue a goal according to a vigilant strategy and loss avoidance.

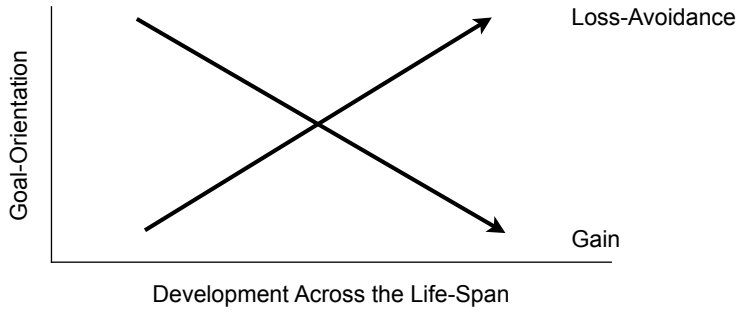

Figure 1. Schematic life span developmental trajectories of goal orientation toward approaching gain and avoiding loss (based on Staudinger, Marsiske, & Baltes, 1995)

As goal orientation changes across life span, so might decision-making behavior, given that it is guided by the decision-maker's personal goals. If older adults are more sensitive to potential losses than are younger adults, this could influence decision making in at least three ways that may reflect different manifestations of asymmetrical sensitivity to gains and losses. First, older adults may employ different strategies in the decision-making process compared to younger adults. Moreover, they may focus more on negative aspects of choice options in order to avoid potential negative

consequences. This could manifest in decision-related information processing styles that accentuate negative over positive information. Second, older adults may show different preferences in decisions compared to younger adults. More specifically, older adults may prefer options associated with less potential loss or less likelihood for a loss to occur, thereby avoiding risk. Third, older adults' decision making could involve differential emotional responses to losses compared to gains, with stronger responses to losses compared to gains. These potential ways in which increased sensitivity to losses in decision making in older adults could manifest are the subject of the current research.

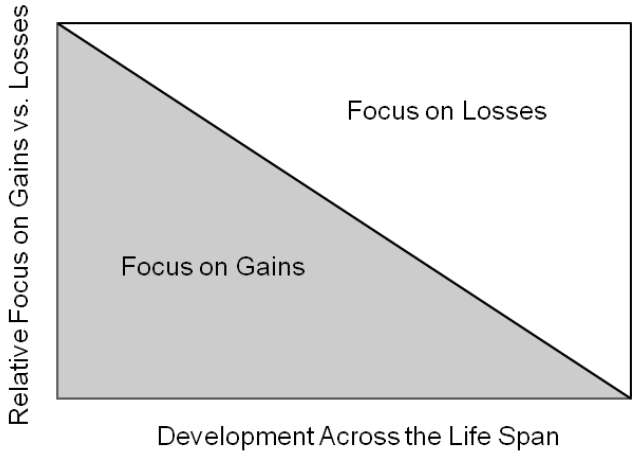

Figure 2. Schematic depiction of the hypothesized shift in relative focus on gains and losses in decision making

Overview

In the following chapters, I will first give an in-depth introduction of the theoretical background that was briefly outlined above (Chapter I). In Chapter I, I will present a review of previous findings on age-related changes in the sensitivity to gains and losses and introduce the motivational prevention-of-loss hypothesis that guided the empirical studies presented in Chapters II and III. Furthermore, I will address key issues for future research (e.g., the role of monetary and non-monetary incentives) and discuss some applied consequences. One way in which the

motivational prevention of loss hypothesis could manifest in decision making lies in asymmetrical information processing of positive and negative choice features. Therefore, second, I will present an experimental approach to investigating whether older adults process decision-related positive and negative information differently compared to young adults in the decision domains of leisure (Experiment 1; Chapter II) and health (Experiment 2; Chapter II). The experiments presented in Chapter II compare age-related differences in information processes indexed by incidental memory. In order to clarify whether potential age-related differences in information processing are specific to decision making, information processing is compared in a choice condition to a control condition. Third, I will present an empirical test of the question of whether age groups differ with respect to choosing risky outcomes (Chapter III). Building on the discussion of type of incentive in Chapter I, this experiment investigates decision making in a new non-monetary, non-hypothetical gambling task. Furthermore, the experiment in Chapter III investigates age-related differences in emotional reactions to gains and losses operationalized as autonomic reactions (heart rate change, skin conductance responses). In the study, I also extend the age-comparative perspective of young and older adults to adolescents. Adolescents are particularly interesting with respect to the relative importance of gains and losses for decision making because they have been argued to be strongly approach-oriented with a neglect of avoidance of negative outcomes for the sake of immediate pleasure. That means adolescents may present a behavioral pattern opposite that of older adults. In Chapter III, an experimental approach tests whether adolescents, young and older adults differ in their choices of risky options, whether adolescents are more strongly driven by gains compared to young adults, and whether this effect reverses in older adults compared to young adults. Table 1 summarizes the guiding questions of each chapter. A general discussion addresses, among other issues, the functions of asymmetrical processing of gain-related (positive) and loss-related (negative) information, limitations of the presented research, and future directions.

Table 1. *Overview of Guiding Questions of the Three Following Chapters*

Chapter I	From a motivational perspective, why should there be age-related differences in decision making? How could age-related differences in the relative emphasis of gains and losses in decision making manifest?
Chapter II	Does information processing in decision making differ between young and older adults? Is the (potential) difference in information processing specific to decision making? Does information processing vary as a function of content domain (leisure vs. health)?
Chapter III	Do adolescents, young and older adults differ in their choices for risky options in a non-hypothetical, non-monetary gambling task? Is there an age-related difference in the willingness to accept risk depending on the incentive (money vs. time)? Are there age-related differences in the emotional reactions to gains and losses?

CHAPTER I:

NORMAL AGING AND DECISION MAKING:

THE ROLE OF MOTIVATION

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Abstract

The main argument of this review is that motivational development associated with normal aging affects decision making. With increasing age, the ratio of gains to losses becomes more and more unfavorable. Reflecting the increasing losses in resources, goal orientation changes from a predominant orientation towards gains in young adulthood to an increasingly stronger orientation towards the prevention of loss in older adulthood. As goals serve as reference points for the evaluation of decision outcomes, this change in goal orientation across adulthood might also affect decision making. The decision-making literature has recognized that choices are influenced by goal orientation. The well-known framing effect shows that decisions differ depending on the framing of the outcomes as gains or losses. However, little research has been conducted on how goals influence the decision-making process in general and with regard to aging in particular. To date, findings on decision making and aging remain inconsistent and are in need of a developmental framework. With regard to applications, a better understanding of the aging decision maker can provide insight into how to improve communication efforts about issues like advance care planning, medical treatment, and housing options.

Normal Aging and Decision Making: The Role of Motivation

Older adults face important and complex decisions such as which health care provider to choose, which housing arrangements to make, or how to manage their financial resources. Understanding age-related changes in the decision process may help us to design decision contexts in a way that enables older adults to make optimal decisions. Only little is known, however, on the effect of normal aging on decision making (but see Mata, Josef, Samenez-Larkin, & Hertwig, 2011; Mather, 2006; Sanfey & Hastie, 2000).

One of the main propositions of life-span psychology is that aging does not represent a uniform trajectory across different domains of functioning, but instead is multidirectional (Baltes, 1987). In other words, normal aging comprises different developmental changes in different functional domains such as cognition, emotion, and motivation. For instance, whereas fluid intelligence declines across adulthood, crystallized intelligence is fairly stable well into old age (Li et al., 2004). These age-related cognitive changes have been shown to influence decision making in older adults (e.g., Bruine de Bruin, Parker & Fischhoff, 2012; Mata, 2007; Mata, Schooler & Rieskamp, 2007; Peters & Bruine den Bruin, 2011). Importantly, different kinds of decision-making tasks may draw more or less on fluid or crystallized aspects of cognitive functioning such as information processing speed or working memory capacity, on the one hand, or on experience in making choices and in dealing with gains and losses associated with their choices, on the other (Mata et al., 2011). Thus, it is not surprising that there is empirical evidence supporting an age-related decrease as well as stability in decision-making competence (for reviews, see Bruine de Bruin et al., 2012; Yoon, Cole, & Lee, 2009).

Going beyond cognitive functioning, some authors have drawn attention to the importance of socioemotional changes (e.g., Mather, 2006; McCarrey, Henry & Luszcz, 2010). In particular, there seems to be an age-related increase in people's reliance on affective information, which may

allow older adults to compensate for cognitive decline in some decisions (Finucane, 2008; Hanoch, Wood & Rice, 2007; Peters & Bruine de Bruin, 2011). A meta-analysis on pre-decisional information search suggested that the aging decision maker tends to consider fewer pieces of information when making decisions, but that this may lead to only minor losses in decision quality, reflecting an effective strategy (Mata & Nunes, 2010). There is also an emerging literature on neuroeconomics and aging that covers neuropsychological changes in older adulthood and their impact on decision making (for reviews, see Brand & Markowitsch, 2010; Brown & Ridderinkhof 2009; Mohr, Li & Heekeren, 2010). In addition to age-related cognitive, neuropsychological, and socioemotional changes, we posit that *motivational* changes regarding people's orientation towards gains and losses also influence how they make decisions in different areas of their lives. It is interesting that age-related motivational changes in people's goal orientation towards gains or losses have largely been neglected in decision-making research. This is surprising as the motivational concept of goals plays a crucial role in the decision-making process, particularly in the evaluation of choice options. For instance, Yates and Patalano (1999) stressed that the special nature of decision making lies in the subjective value of what is perceived as a satisfying outcome. The construal of what constitutes a satisfying outcome most likely depends on what the decision maker wants to achieve or avoid, respectively.

As Hastie (2001, p. 656) put it: "Good decisions are those that effectively choose means that are available in the given circumstances to achieve the decision maker's goals." According to this definition of a "good choice," the decision maker's goals and the means at his or her disposal are essential in the decision-making process. Importantly, both goals and available means are subject to developmental change. Hence, we posit that age-related changes across adulthood in the predominant motivation to achieve gains or avoid losses are related to age-related changes in decision making. Note that we do not advocate the notion of a general decline in decision-making

"performance," with older adults making worse decisions than younger adults. Instead, we argue that, although adults of all ages want to achieve gains and avoid losses when making decisions, younger adults might be more motivated than older adults to base their decisions on the motivation to achieve gains. In contrast, older adults might be more motivated than younger adults to avoid losses when making decisions.

Two of the most striking changes that occur in normal aging are an increase in losses in various life domains (e.g., fluid intelligence, physical performance, health) and a decrease in gains (Baltes & Smith, 2003), leading to an overall decline in the availability of resources (Baltes, 1997). How does the experience of this change in gains and losses and the availability of resources across adulthood affect how we make decisions? We posit that motivational changes related to the changing ratio of gains to losses across adulthood profoundly affect the process of decision making. More specifically, we propose that age-related changes in goal orientation from a predominant gain orientation to an increasing importance of the prevention of losses across adulthood (Freund & Ebner, 2005) affect decision making in the following way: The goal of preventing losses might increase the salience of potential losses (relative to gains) when older adults make a decision. The corresponding "vigilant" or conservative decision-making strategy aims at avoiding losses by reducing costly errors and helping to evade threat (e.g., Crowe & Higgins, 1997). Hence, the aging decision maker may show a stronger sensitivity to losses and a weaker sensitivity to gains as compared to younger adults. Note that our perspective does not conflict with the idea that decision making in older adults might be affected by cognitive, neuropsychological, and socioemotional changes. Instead, we believe that motivational changes across adulthood and their potential impact on decision making have been largely overlooked in the literature. We posit that motivational changes in people's orientation towards gains and losses influence information processing and decision strategies. Complementing research on older decision makers' stronger reliance on

affective information (Finucane, 2008), we hypothesize that the motivational orientation towards gains or losses may influence the *kind* of affective information (gain- vs. loss-related information) older adults rely on more.

In sum, this review elaborates on how motivational changes in goal orientation associated with normal aging may affect the decision-making process. This paper is divided into six sections: (1) the dynamics of gains and losses in normal aging, (2) goal orientation across adulthood, (3) motivational factors in decision making, (4) gains and losses in decision making and aging, (5) key issues for future research, and (6) applied consequences.

The Dynamics of Gains and Losses in Normal Aging

Developmental gains and losses are present throughout the entire life span and involve internal as well as external resources (e.g., sensorimotor, cognitive, physical, and social resources; Baltes, 1987, 1997). With increasing age, adults increasingly face losses in resources due to declining health and cognitive functioning, retirement, and the death of loved ones (e.g., Baltes & Smith, 2003). There is high consensus among adults of all ages regarding the expectation of predominating gains in younger adulthood and an increasing number of losses in middle and late adulthood (Heckhausen, Dixon, & Baltes, 1989; Heckhausen & Krueger, 1993; Mustafic & Freund, 2012).

According to Hobfoll's (1989, 1998) conservation of resources theory, when people are faced with the threat of resource losses, preventing loss becomes more important than acquiring new resources (see also Freund & Riediger, 2001). Accordingly, as people age and thereby increasingly encounter losses, their goal orientation should shift from growth (gains) in young adulthood to maintenance and prevention of loss in older adulthood (e.g., Ebner et al., 2006; Freund, 2006; Freund & Ebner, 2005; Heckhausen, 1997; Staudinger et al., 1995). Goal orientation is likely to influence decision making by influencing information processing as well as the evaluation of decision outcomes. Whereas younger adults may process decision-related information and

evaluate decision outcomes primarily with respect to gain maximization, older adults may focus more on and favor information related to outcomes that ensure the avoidance of losses.

Goal Orientation across Adulthood

In the motivational literature, there is a fundamental distinction between approach and avoidance motivation (e.g., Emmons, 1996), which corresponds roughly to a distinction between goals that are oriented towards gains or growth and goals that are oriented towards the maintenance of functioning or the avoidance of loss (Freund & Ebner, 2005). Similarly, regulatory focus theory (Higgins, 1998) distinguishes between promotion and prevention focus where promotion focus describes the orientation towards approaching something desired and prevention focus the orientation towards avoiding something undesired. Regulatory focus is also reflected in strategies of goal pursuit as either eager (i.e., attempting to not leave out any possibility to promote gains) when adopting a promotion focus or as vigilant (i.e., attempting to avoid any risks and watching out for possible danger for losses) when adopting a prevention focus.

Across adulthood, motivation shifts from a primary growth orientation (i.e., achieving gains) to an increasing importance of maintaining resources and preventing losses (Freund & Ebner, 2005). Ebner et al. (2006) found that younger adults described their personal goals as primarily oriented towards growth, whereas middle-aged and older adults increasingly described their personal goals as being directed at maintenance and prevention of loss. Converging evidence is provided by self-report studies of personal goals by Heckhausen (1997) and Ogilvie, Rose, and Heppen (2001). Experimental studies suggest that this shift is due to the availability of resources. Younger adults shifted from a gain to a loss orientation when their resources were perceived as restricted (Ebner et al., 2006).

Is this shift in goal orientation adaptive? In the Ebner et al. (2006) study, loss orientation was negatively related to subjective wellbeing in young but not older adults, and maintenance

orientation was even positively associated with subjective wellbeing in older adults. In younger adults, goal orientation towards the avoidance of losses was correlated negatively with subjective wellbeing. This speaks for an age-differential adaptiveness of goal orientation across adulthood. Further attesting to this pattern, Freund (2006) found in a set of experiments that older adults were more persistent in pursuing a task geared towards counteracting losses, whereas younger adults were more persistent when they pursued the same task geared towards achieving gains. We find it interesting that this age-related difference in persistence was unrelated to task performance. In other words, the driving force for persisting in goal pursuit was not how well younger or older adults performed on it but, instead, the framing of the task as gain or loss related. Taken together, these studies provide empirical evidence supporting the notion of a shift in goal orientation from gains to losses across adulthood that is adaptive regarding behavioral indicators of motivation as well as subjective wellbeing. The consequences of this shift in goal orientation on decision making in normal aging will be discussed in greater detail after we review studies on the impact of motivation on decision making.

Motivational Factors in Decision Making

Economists usually view behavior as an attempt to maximize gains and minimize losses or as the quest for pleasure and the escape from pain (e.g., Camerer, Loewenstein & Prelec, 2005). Although it has long been recognized that choices are influenced by goals (e.g., Heath, Larrick, & Wu, 1999; Higgins, 1997; Kahneman & Tversky, 1979; Rangel, Camerer & Montague, 2008; Tversky & Kahneman, 1981; Yoon et al., 2009), the way in which goals influence choice has been largely neglected. For instance, prospect theory proposes that the value (utility) of an outcome is the result of how far it deviates positively or negatively from a reference point (Kahneman & Tversky, 1979). Although it has been acknowledged that goals may serve as reference points in the evaluation of outcomes (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981; Heath et al., 1999; Locke &

Latham, 1990; Mento, Locke, & Klein, 1992), most applications of prospect theory have not taken individual goals into account. Instead, the *status quo* is assumed to serve as a reference point. Taking the notion of personal goals as setting comparison standards seriously, one might assume that goal orientation has an important impact on the evaluation of an outcome, independent of the status quo. For instance, if the goal is to prevent a serious loss, a less severe loss might be experienced as a gain. Conversely, if the goal is to achieve a very high gain, a lower gain might be experienced as a loss. Similarly, Idson, Liberman, and Higgins (1999) argued that the difference in hedonic experience of gains and losses (i.e., as how rewarding or punishing an outcome is experienced) depends on the person's motivation to either promote gains or prevent losses. More specifically, they argued that the presence or absence of a gain (gain vs. non-gain) or a loss (loss vs. non-loss) is experienced differently depending on whether a promotion or prevention focus was adopted. When trying to prevent a loss, not losing can feel like winning. A gain will usually be experienced as pleasurable, but may be experienced as even more pleasurable if it was not expected (e.g., Mellers, 2000). In sum, the value of an outcome is subjective and depends not only on the status quo, but also on the decision maker's goals and expectations. This, in turn, might influence the decision-making process. As argued by Mellers (2000) in her subjective expected pleasure theory, decision makers anticipate the pleasure and pain of outcomes and select choices with greater average pleasure.

To date, most studies directly investigating the impact of goals on decision making have only used samples of young adults. Some have argued that existing research on how goals influence

decisions under uncertainty[1] in young adults suggests that pursuing a goal increases risk taking. For instance, in one experiment participants cheated more when they wanted to reach a certain goal (Schweitzer, Ordonez, & Douma, 2004). In another study, participants accepted more risks to reach an actual monetary goal (Larrick, Heath, & Wu, 2009). Note, that these studies investigated decision making in the context of gain-oriented goals.

Very few studies have investigated the differential effects of goals directed at growth or at the prevention of loss on decision-making strategies. In one of the few exceptions, Crowe and Higgins (1997) looked at the effect of an experimentally induced prevention or promotion focus in young adults on the performance in a signal detection paradigm. In this task, participants had to press "yes" or "no" depending on whether a signal was presented or not. The authors found that young participants with an experimentally induced prevention focus had a bias towards pressing "no" (i.e., adopting a vigilant strategy). Conversely, persons with an experimentally induced promotion focus had a bias to press "yes" (i.e., adopting an eager strategy). The authors argue that these biases reflect differences in the general decision strategies used when people hold a prevention or a promotion focus: According to Crowe and Higgins, prevention focus is associated with the tendency to be cautious in order to avoid mismatches to desired end states (vigilant strategy), whereas a promotion focus is related to jumping at opportunities that might help one to achieve desired end states (eager strategy). Further supporting the notion that a conservative or vigilant decision strategy is used when a prevention focus is adopted, Chernev (2004) found in a study on consumer preferences that young adults more strongly preferred the status quo over changing their

[1] In the decision-making literature, "uncertainty" typically refers to situations in which outcomes are unknown and uncertain, whereas in risky situations uncertainty can be predicted by defined probabilities (e.g., Bechara, 2004).

selection of an object (here: a digital camera) when they had been primed to be prevention- as compared to promotion-focused.

Importantly in the current context, these studies demonstrate that people's decision strategies are related to their motivation to promote growth or prevent losses. Note, that these studies were based on college-aged samples and, therefore, cannot address possible age-related effects. They can be used, albeit with caution, as a basis for speculating about decision-making differences between gain-oriented (promotion-focused) younger adults and loss-prevention-oriented older adults. Motivational changes in goal orientation might lead older adults to become more vigilant and conservative decision makers in order to avoid further losses and secure the maintenance of resources. This might lead to an increasing asymmetry in the importance older adults place on losses compared to gains when making decisions, such that they become more sensitive to and react more strongly to losses than younger adults do. Consequently, older adults might attend more to information related to potential losses when making a decision, and to weigh such information more heavily than gain-related information. Increased motivation to avoid losses in older adults might also be associated with a preference for familiar options in order to minimize the chances of unpredictable losses. In repeated or rule-based decisions, an increase in loss orientation in older adults may result in a response bias to avoid costly errors rather than maximize possible gains (similar to those shown by Crowe and Higgins, 1997, in younger, prevention-focused adults).

Note, that there may be fundamental differences between older adults' general goal orientation towards the prevention of losses and younger adults' adoption of a prevention focus. For younger adults, having to prevent losses might constitute the exception to the rule of maximizing gains. As a consequence, they might react even more strongly to losses than older adults for whom losses are expected and more common. Moreover, for older adults, the prevention

of a loss might actually be motivating and considered positive (Ebner et al., 2006; Freund, 2006). In constrast, for younger adults having to prevent losses might be a stronger signal of something going wrong because losses are rather unexpected during this phase of the life span (Freund & Riediger, 2001).

Gains and Losses in Decision Making and Aging

In the classic decision-making literature, gains and losses mostly refer to monetary gains and losses in experimental decision-making tasks. Asymmetries in gain-loss processing in decision making are well accepted: Loss aversion, for example, has been called "the most successful and widely used explanatory construct in behavioral decision research" (Brenner et al., 2007, p. 369; for critical perspectives on when loss aversion occurs see Hertwig, Barron, Weber, & Erev, 2004; Yechiam & Ert, 2011). Loss aversion denotes a higher impact of losses on a choice than do equivalent gains. The construct was initially formalized as a component of prospect theory, an analysis of risky choices to explain risk aversion in monetary decisions (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992).[2] Loss aversion was also used in the domain of riskless choice to explain effects such as the endownment effect (Kahneman, Knetsch & Thaler, 1990) and other phenomena (see Novemsky & Kahneman, 2005). According to prospect theory, changes for the worse (losses) loom larger than equivalent changes for the better (gains; Kahneman & Tversky, 1984; Tversky & Kahneman, 1991). For example, when asked to accept or reject a 50 : 50 bet to either win or lose a certain amount of money, participants usually accept when the potential gain is

[2] Note that, within the framework of prospect theory, risk does not denote uncertainty, but the precise probabilities of several specific alternatives such as the 10% probability of dying of unwanted side effects after receiving a vaccine that, on average, increases the probability of surviving a corresponding infection to 80%.

at least twice as high as the potential loss. This reflects a strong asymmetry of gains and losses in decision making. Despite the seeming ubiquity of loss aversion, the literature suggests that decisions from experience differ strongly from decisions from description (Hertwig et al., 2004). Moreover, Yechiam and Ert (2011) found only moderate consistency within subjects across different tasks and between description-based problems presented in different domains. We propose that loss-aversion might also depend on the decision maker's goal orientation. In the following, findings about *age-related changes* in the asymmetry of gains and losses in decision making will be reviewed.

On the basis of the motivation literature, we argued above that older adults might be more sensitive to and place greater importance on losses than younger adults during the decision-making process. Findings from the reinforcement learning literature are in line with this reasoning. Frank and Kong (2008) showed that age had a significant effect on the bias to avoid negative outcomes. Older seniors (M = 77 years), but not younger seniors (M = 67 years), showed an increased tendency to learn from the negative as compared to positive consequences of their decisions in a probabilistic selection task. This finding supports the idea that older adults grow increasingly vigilant towards losses. Moreover, the difference between younger and older seniors shows that the tendency to learn from losses becomes increasingly pronounced in old age. Note, however, that a recent meta-analysis by Mata and colleagues (2011) showed that, in general, older adults seem to profit less from feedback in repeated decisions. The authors interpret this finding as reflecting age-related cognitive changes that make learning more difficult for older compared to younger adults.

A number of studies that investigated asymmetries in the processing of gains and losses in decision making employed the Iowa Gambling Task (IGT; Baena, Allen, Kaut & Hall, 2010; Denburg, Bechara, Tranel, Hindes & Damasio, 1999; Denburg et al., 2007; Denburg, Recknor, Bechara & Tranel, 2006; Denburg, Tranel & Bechara, 2005; Kovalchik, Camerer, Grether, Plott & Allman, 2005; MacPherson, Phillips, & Della Sala, 2002; Wood, Busemeyer, Koling, Cox & Davis,

2005). The results of this line of studies present a mixed picture. The IGT requires participants to draw cards consecutively from different decks that correspond to different monetary losses and gains. The correspondence of decks to gains and losses is unknown to the participants. There are four decks, two of the decks with high payouts but even higher losses, and two decks with low payouts but also lower losses. The aim of the task is to win as much money as possible by making advantageous card selections. Over trials, selections from the low-gain-low-loss decks produce a net gain across trials, whereas selections from the high-gain-high-loss decks produce a net loss across trials. Participants ideally develop a bias towards the advantageous decks resulting in a net gain across trials. Less advantageous decisions in the task favor larger versus smaller rewards, despite the large losses associated with the same deck and thus long-term negative consequences. The trials are divided into blocks, which allows comparing the proportion of advantageous selection across blocks as an indicator of learning. Denburg et al. (1999) tested a population of healthy older adults with the IGT and found that older adults did not demonstrate a shift over time from the decks that produce a net loss to the decks that produce a net gain. Fein, McGillivray and Finn (2007) replicated the finding that older adults chose less advantageously compared to young adults and showed a positive association of older adult's performance with immediate memory. As pointed out by Mata and colleagues (2011), this might be due to decreased learning from feedback in older adulthood. In other studies, Denburg and colleagues (2005, 2006, 2007, 2009) found that performance on the IGT might be impaired in a subset of older adults. Furthermore, Denburg and colleagues (2006) administered the IGT and measured psychophysiological correlates of decision making (anticipatory skin conductance responses that participants produced immediately prior to the response) in a sample of elderly participants. Older adults with non-impaired decision making on the IGT showed a stronger physiological response to anticipated gains than to anticipated losses. In contrast, younger adults responded more strongly to anticipated losses than gains. Older adults with impaired

decision making on the IGT did not demonstrate discriminatory anticipatory skin conductance responses for advantageous versus disadvantageous choices. Thus, learning from feedback in repeated decision-making tasks seems to be associated with (and may even depend on) an intact discriminatory response to gains and losses. Whereas these findings seem to suggest that younger adults learn more from loss-related feedback over time than older adults, other studies could not replicate these findings. For instance, several studies found no significant age-related differences in IGT-performance (Baena et. al., 2010; Lamar & Resnick, 2004; McPherson et al., 2002). Similarly, Kovalchik and colleagues (2005) showed that older adults shifted to the gain payoff decks just like younger adults did. Wood and colleagues' (2005) analyses of the IGT showed that older adults' strategies differed in several ways: Older adults exhibited larger recency effects and faster forgetting of previous outcomes. Furthermore, older adults placed an equal emphasis on gains and losses whereas younger adults placed greater weight on losses. Importantly, older adults showed symmetrical weighing of gains and losses that contrasted to the "negativity effect" reflected in the responses of young adults, who were greatly influenced by losses. This symmetrical weighting of gains and losses has been interpreted as an accurate representation of gains and losses (Peters & Bruine de Bruin, 2012).

The majority of these findings suggest un-impaired performance on the IGT in older adults in that they shift to advantageous decks across trials. However, as the analyses by Wood and colleagues suggest, un-impaired performance on the IGT can be a result of different strategies. The task was originally developed to capture the integration of emotion and cognition in decision making (Bechara el al., 1994). The task comprises a variety of features such as weighing risks and benefits, making decisions under uncertainty and dealing with unknown outcomes (Denburg et al. 2009). Although the task requires dealing with gains and losses, unfortunately, it does not assess the sensitivity to gains and losses. In fact, there has been some criticism in the literature that it is unclear

what the IGT actually measures. For instance, Frank and Kong (2008) suggest that the IGT might be sensitive to age-related decline in working memory. More precisely, trial-to-trial behavior on the IGT might reflect a sensitivity to the recency of positive and negative outcomes, which may depend more on working memory than on learning. Another problem with interpreting decision behavior on the IGT as reflecting sensitivity towards gains and losses is that it might tap more into risk attitudes (risk aversion and risk seeking), as the probabilities of gains and losses vary in the task. In a meta-analysis on risk preferences, Mata and colleagues (2011) showed that in decisions from experience (as, for instance, required by the IGT), age-related differences in risk-taking were driven by decreased learning in older adults. Older adults act more risk averse compared to young adults, when learning led to risk seeking behavior. In contrast, older adults were more risk seeking compared to younger adults when learning resulted in risk avoidance (Mata et al., 2011). Age-related difference in the performance on the IGT (and potentially also on other experience-based decision tasks) might partly depend on an age-related decrease in learning. If learning is a necessary process for performance on the IGT, it is unlikely that motivational effects modulate age-related differences. Put differently, age-related difference in motivation might not have a chance to influence performance on the IGT if older adults have more problems learning the risk contingencies. Therefore, in tasks such as the IGT or other decision tasks involving learning, we do not expect age-related differences in motivation to play an important role for risk aversiveness. More generally, the monetary incentives could lead to systematic differences between age groups. This might be the case because monthly income as well as the general importance of money may differ (as will be discussed below in more detail). In addition, people do not appear to exhibit loss aversion for small amounts of money. On the contrary, people expect small gains to be more pleasant than they expect small losses to be unpleasant (Harinck, Van Dijk, Van Beest, & Mersmann, 2007). Hence,

the reward structure in the IGT may not be a suitable to measure loss aversion or single out the impact gains and losses have on task performance.

Another set of studies that investigated the asymmetries of gains and losses in old age employed the monetary incentive delay task (MID task; Knutson, Adams, Fong, & Hommer, 2001). In each MID task trial, participants view one of six different cues displaying the amount of money that can be gained or lost on that trial (anticipation phase). If the participant responds quickly enough to a subsequent target, he or she either gains money or avoids losing money (outcome phase). Importantly, this task does not require a decision. However, the task allows distinguishing between the anticipation of gains versus losses. Using the MID task, Nielsen, Knutson and Carstensen (2008) found that older adults showed less increase in arousal when anticipating a loss compared to a gain, whereas younger adults showed increased negative arousal during loss anticipation and positive arousal during gain anticipation. Moreover, older adults showed less relief compared to young adults when a loss did not occur even if it was expected. The authors concluded that these findings support the hypothesis that older adults experience less negative emotions than young adults and that they may better predict dynamic changes in affect. Yet, as mentioned above, in the case of small monetary gains and losses, loss aversion reverses such that people expect small monetary gains to be more pleasant than they expect small losses to be unpleasant (Harinck et al., 2007). Given this finding, the results presented for older adults are not surprising with respect to the size of the monetary gains and losses employed in the study. The highest gain or loss was $5, which can be considered small in terms of Harinck's findings (Nielsen et al., 2008). The finding that older adults reported increased positive arousal on trials involving gain anticipation but no increase in negative arousal on trials involving loss anticipation might be due to the small magnitude of expected losses. In contrast, younger adults show increased negative arousal during loss anticipation and increased positive arousal during gain anticipation. In this case, the authors acknowledge that

older adults seem better in affective forecasting. Note also, that this study used monetary incentives, which might be stronger for younger as compared to older adults (Freund & Blanchard-Fields, 2011). Thus, in our view, the results of the Nielsen et al. study do not allow us to conclude that older adults show a general tendency to experience less negative affect when anticipating loss. In fact, it seems more deserving of an explanation why younger adults *failed* to discount the small losses. One potential explanation could be that accumulated experience with losses has taught older adults to anticipate that small losses will not be very painful, thereby reducing an affective forecasting error.[3]

In another study, the monetary incentive delay (MID) task was used in event-related functional magnetic resonance imaging (Samanez-Larkin, Gibbs, Khanna, Nielsen, & Carstensen, 2007). Results suggest similar patterns of neural activation in young and older adults during anticipation of gains (increased ventral striatal activation in both groups) but not of losses (increased insular and medial caudate activation in younger, but not in older participants). Importantly, the observed differences between younger and older adults pertained to the *anticipation* of losses. There were no differences in response to the negative outcomes themselves. Furthermore, the reduced reactivity to the anticipation of loss did not reflect the magnitude of negative outcomes. Samanez-Larkin and colleagues concluded that these findings present an asymmetry in the processing of gains

[3] Loss aversion has been argued to be an affective forecasting error in that people overestimate the hedonic impact of losses because they underestimate their tendency to rationalize losses and overestimate their tendency to dwell on losses (Kermer et al., 2006). This argument is based on findings from a gambling task. It may be that the smaller forecasting error ("forecasting expertise") older adults showed in the study by Nielsen and colleagues (2008) for small monetary gains expands to other kinds of gains as losses (larger gains and losses, non-monetary gains and losses).

and losses in older compared to young adults. They argue that this difference is important in decision making. However, the MID task does not comprise decisions. Therefore, only conclusions can be drawn about how age groups process and anticipate certain outcomes. Seen in this light, the findings of these two MID studies support the notion that older adults expect to experience losses, whereas younger adults expect to experience gains (Heckhausen et al., 1989). Currently, we can only speculate about how anticipated outcomes and the subjective anticipated pleasure or pain affects actual decision making. In the MID task, participants control the outcomes by reacting as fast as possible. As reaction times decrease with age, older adults might have experienced less control over the outcomes in the presented studies. In consequence, older adults might expect losses in loss trials and no win in gain trials. This, in turn, might result in differences between older and young adults in subjectively experienced pleasure as the standards of comparison are different for older and young adults (see above; Mellers, 2000). This might be particularly important when people have to make a decision. In fact, it would be very interesting to employ an MID task that requires a decision when investigating adult age differences in gain and loss sensitivity for the decision-making process.

In a study on *risky* decision-making employing the cups task (Levin & Hart, 2003), Weller, Levin and Denburg (2010) showed that age-related differences in risky decision-making occurred depending on whether the expected outcome constituted a gain or a loss. In the cups task, there are distinct trials in which the participants can either achieve small monetary gains or avoid small monetary losses. Unlike the IGT, the cups task does not involve mixed outcomes of gains and losses. Results show that younger and older adult's willingness to take a risk did not differ in the loss trials. Yet, older adults were less willing to take a risk in the gain trials (Weller et al., 2010). Older adults, then, may be less willing to accept a potential loss (not winning) when they can prevent it. When facing a loss, however, and taking a risk becomes the only means to avoid the loss, younger and older adults do not differ in their performance on the task.

In another study on risky decision making, Mikels and Reed (2009) developed a new monetary incentive task in which young and older adults chose between sure options and risky gambles. The authors showed that positively framed options appear to have equal impact on older and younger individuals but that negatively framed options lead to a greater willingness to take a risk in older adults (Mikels & Reed, 2009). This result contrasts the findings of Weller and colleagues (2010) leading to a mixed picture regarding risky decision-making in old age. Again, one could argue that, although the decisions are personal and non-hypothetical, monetary incentives might not be equally important to both age groups. Additionally, the gambles entail different probabilities for both gains and losses within one option, which might make the task difficult to understand for participants (for a discussion of the difficulties in understanding probabilities see Gigerenzer, 1997; Cosmides & Tooby, 1996).

In conclusion, findings on age-related differences in the asymmetry of the impact of gains and losses on decision making are inconsistent (see also Mata et al., in press). Frequently, symmetries in the processing of gains and losses in older adults is contrasted to an emphasis on losses in younger adults and interpreted as a positivity bias in older adulthood. Clearly, more research is needed to understand the potentially changing relative impact of gains and losses on decision making across adulthood. The methodological shortcomings in the studies reviewed above need to be addressed in future studies before a conclusion can be drawn. More specifically, the tasks used in these studies should require decisions, monetary incentives should be large enough to detect the "losses loom larger" effect, and performance on the task should not be bound to reaction times, which are well-known to decrease in older adulthood (e.g., Li et al., 2004). As we will point out in the following section, it might be useful to employ non-monetary incentives when studying aging and decision making. Finally, if the decision makers' goals influence decision making as situational factors, these may result in a variation of the sensitivity to losses across different decision domains.

Key Issues for Future Research

To date, the empirical basis is insufficient to allow well-grounded conclusions about the way motivational development in aging influences decision making. However, the implications of motivational changes may be relevant to understanding the aging decision-maker and may also help to explain current inconsistencies in research on decision making and aging. Understanding the aging decision-maker can provide insight into how to improve communication efforts about issues such as advance care planning, medical treatment, or housing options.

In addition to the methodological suggestions above, several issues need to be addressed in future research: The kinds of incentives employed in experimental studies on decision making (monetary vs. non-monetary incentives), the comparison of decision making in different life domains, and the dynamics across different phases in decision making.

Monetary and non-monetary incentives. Most of the studies reported above investigated decision making in tasks with monetary gains and losses. However, money might not be equally important to young and older adults (Mata et al., in press). In fact, a study by Freund and Blanchard-Fields (2013) suggest that there might be age-related change in the incentive value of money. When facing a trade-off between the maximization of one's personal monetary outcome and the protection of the environment, older adults were more environmentally-minded at the cost of actual monetary payment, whereas the opposite pattern was true for younger adults. Moreover, older adults were more willing to donate money they had earned for participation in an experiment to a good cause instead of keeping it for themselves. Obviously, an important advantage of monetary incentives is that gains and losses can be easily experimentally manipulated and balanced in magnitude of absolute value. In contrast, it is very difficult to balance the magnitudes of gains and losses in non-monetary incentives. However, when investigating the relative impact of gains and losses, it is crucial to establish the equivalence of the intensity of gains and losses in order to rule out

an intensity effect (Peeters & Czapinski, 1990). When comparing age groups, balancing the intensities of stimuli becomes even more complex. Findings by Keil and Freund (2009) show that high emotional arousal was experienced as negative by older adults, regardless of whether the stimulus was positive or negative. In contrast, younger adults showed a clear pattern of rating more arousing positive stimuli more positively. If arousal becomes aversive in older adults, they might weigh certain outcomes differently than younger adults do regardless of the valence of the outcome. Thus, potential age differences in stimulus evaluation need to be taken into account. Stimulus materials should ideally be rated on both valence and arousal dimensions.

Domain-related differences. In evaluating options, decision-makers may place different emphasis on either gains or losses depending on the domain (e.g. what the decision is about), such as finance, health or social relationships. Developmental expectations regarding gains and losses in different domains may underlie such domain-related differences (Mustafic & Freund, 2012). Thus, the sensitivity to and weighing of gains and losses does not represent a domain-general trait but rather the interaction between the situation (e.g., availability of resources) the and decision maker (e.g., gain or loss orientation; Figner & Weber, 2011; Yechiam & Ert, 2011). Accordingly, the investigation of different decision domains that systematically vary along dimensions such as the availability of resources seems particularly interesting for further understanding under what conditions people are more likely to show loss aversion. Moreover, from a developmental perspective, some life-domains grow increasingly important across adulthood while other domains may lose their importance. For example, social relationships become increasingly important in old age (Lang & Carstensen, 1994). Moreover, research in the context of socioemotional selectivity theory (SST) has shown that the quality and satisfaction with social relations do not decline across adulthood but might even show gains (Carstensen, Isaacowitz, & Charles, 1999). This might also be reflected in older adults' goal orientation, which might vary by life domain. Regarding social

relations, younger and older adults might not differ regarding the importance they place on growth, maintenance, and the prevention of loss (Carstensen et al., 1999). This might also affect the impact of gains and losses for decision making.

In contrast, physical functioning and health are subject to age-related decline (Baltes & Smith, 2003) which is also reflected in people's developmental expectations (Mustafic & Freund, 2012). In these life domains, older adults might be particularly sensitive to losses and might show stronger loss-aversion than younger adults. Improvement in communicating information about important health-related decisions may foster successful advance care planning for potential future health issues such as dementia. Hence, understanding how older adults perceive and process information in different domains may help to accomplish this. In sum, future studies should compare the sensitivity to losses in domains in which normative developmental losses are expected (such as declining health and cognitive functioning) and in domains that are not subject to developmental losses (such as social relationships).

Dynamics across the decision-making process. As indicated above, age-related shifts in goal orientation may vary across life domains. Thus, older adults may flexibly shift between different decision-making strategies in different domains and contexts, such as description-based or experience-based decision tasks. In addition, decision makers may flexibly shift between different information-processing strategies and evaluations of the situation in different phases of the decision-making process. This may resolve some apparent contradictions in findings on older adults' processing of gains and losses in decision making. For example, an emphasis on losses when trying to prevent a loss seems most adaptive in the pre-decisional phases. This could change for post-decisional settings when the decision maker has no further control over the outcome. In this phase, focusing on negative or loss-related information has adaptive value only for future decisions, but can no longer affect the past. In repeated decision situations, then, learning from bad choices is

possible. This reasoning is in line with the finding that older adults learn more from negative information in a reward-learning setting in which choices are repeated (Frank & Kong, 2008), but demonstrate a post-decisional positivity bias when this is not the case (Kim, Healey, Goldstein, Hasher, & Wiprzycka, 2008; Mather & Johnson, 2000). As elaborated in the context of the Iowa Gambling Task (IGT), when learning is involved in repeated decisions, older adults might profit less from feedback regarding past choices. In experience-based repeated decisions, the decision maker has to learn the value of options from experience when deciding between risky options. Given the age-related decrease in learning, age-related differences might reflect primarily decreased learning abilities rather than motivational changes (cf., Mata et al., in press). Future studies are needed to dissociate age-related differences in motivation and learning differences in description-based repeated choices.

In conclusion, older adults may not only flexibly adjust their strategies across but also within situations, depending on perceived control and adaptive value of asymmetric evaluations of gains and losses. In our view, this area of research might be particularly fruitful for understanding aging and decision making. In order to address these ideas, future research needs to rely on such methods as process tracing (e.g., using a "mouselab" procedure) that allow to investigate information seeking behavior in different phases of the decision-making process and accompanying emotional responses (e.g. through the measurement of skin conductance responses; Schulte-Mecklenbeck, Kühberger & Ranyard, 2011). A process-tracing approach can also help to clarify which underlying processes may be influenced by loss prevention. Based on the motivational literature and the impact of goals on information processing, we assume that attention and memory are particularly likely to be affected by goal orientation towards gains or losses (e.g., Van Lange, Kruglanski & Higgins, 2011). One important question in this regard concerns the process of information integration: How do younger and older adults integrate different aspects of information into a representation of the decision

options? Do younger adults over-represent gain-related information whereas older adults over-represent loss-related information? This question could be empirically addressed using think-aloud procedures during the decision-making process. Another approach to dissociate different processes in the decision-making process and their integration is offered by the elaboration of computational models. To our knowledge, there do not exist any models addressing the interplay of motivation and cognition in explaining age-related differences in the decision making process.

Applied Consequences

Older adults frequently need to make informed choices about important issues such as health care, medical treatment, insurance, financial plans, advanced care planning, and housing. However, informed decision making is a double-edged sword. On the one hand, it allows people to be autonomous and to make their own decisions regarding these important issues according to their own preferences. In favor of informed choice, some researchers argue that older adults can make advantageous decisions when complete information is available to them (Zamarian, Sinz, Bonatto, Gamboz, & Delazer, 2008). On the other hand, this autonomy may also place a burden on decision makers as they are confronted with a vast amount of information and complex choice settings. As shown by Schwartz (2004), there might be something akin to a "tyranny of choice," in that having more options available leads to dissatisfaction with one's choice. Moreover, even if all information about all options is available, people are typically unable to process all of the information, which makes making optimal decisions on the basis of this information impossible (Simon, 1982). This might be particularly true in old age when cognitive resources are even more limited than at younger ages (Mata, 2007; Mata et al., 2007). Here, motivational factors might be particularly important for the selection of information. Thus, understanding the motivational factors influencing decision making in older adults can help to improve communication about options in areas such as advance care planning, medical treatment, and housing options. More specifically, an increasing motivation

to prevent losses may lead to changes in decision-making strategies, information search and processing. Hence, communication about choice alternatives should be adjusted accordingly in order to enhance the effectiveness of communication. Consequently, the information presented could be reduced by making information salient that is particularly important to the decision maker's goals, for example, information that is diagnostic for counteracting losses and the maintenance of a current state. The potential to counteract losses or maintain some level of functioning should be emphasized more strongly if the prevention of loss is a central goal for the decision maker. Hence, alternatives should be evaluated and communicated with respect to their potential to counteract losses. Furthermore, pointing out potential gains and benefits of options may be inefficient and suited more for communicating with younger adults. Additionally, understanding how older adults review and process information may lead to implications about how older adults should be instructed to approach choice situations. For instance, Löckenhoff and Carstensen (2007) showed that older adults reviewed more positive information on health care plans when asked to focus on their emotions and less positive information when instructed to focus on specific facts and details. Thus, instructing older adults to focus on facts may eliminate differences between older and younger adults.

Conclusion

In this article, we have argued that motivational shifts in goal orientation towards gains and losses might be important for understanding older adults' decision making. We propose that decision making might change across adulthood towards more vigilant and conservative decision-making strategies aimed at preventing losses. As of yet, the vast literature on loss aversion in decision making has not yet included a life-span perspective. Findings available to date, present a mixed picture of results. We posit that losses loom even larger in older adulthood, a time at which the motivation to prevent losses increases. Older adults might be more sensitive to potential losses

than younger adults. This might have important applied implications for the presentation of information in complex decision contexts for older adults such as health care or financial planning.

CHAPTER II:

WHEN CHOICE MATTERS: TASK-DEPENDENT MEMORY EFFECTS IN OLDER ADULTHOOD

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Abstract

As goal orientation shifts across adulthood from a primary orientation towards gains to an increased importance of the prevention of losses, older adults' information processing may be particularly sensitive to potential losses if there is a possibility to avoid them. In line with these motivational changes, we expected younger adults to remember more loss-related information when having to make a choice for one of two options. Using an incidental memory paradigm, younger and older adults recalled information on two hypothetical travel packages (Experiment 1) or on two hospitals (Experiment 2) containing positive (gain-related), negative (loss-related), and neutral information. Experiment 1 showed that older adults remember more negative information than younger adults (and than positive information) when they had to choose one of the travel packages but not in the control condition (evaluating the readability of the texts). Experiment 2 followed the same procedure using a choice between two hospitals for a minor surgery. This choice was assumed to trigger a stronger orientation towards the prevention of losses compared to the choice between travel packages. As expected, in this choice situation both age groups remembered more negative information relative to neutral and positive information regardless of the condition (choice vs. control). More importantly, results of Experiment 2 again confirmed the hypothesis that older adults focus more on negative information in a choice condition compared to the control condition. Taken together, results suggest that decision-making related information processing promotes a stronger focus on negative information in older adults.

When Choice Matters: Task-dependent Memory Effects in Older Adulthood

Throughout their lives and well into old age, adults face many decisions that can affect their quality of life and wellbeing. Making these decisions often requires reviewing information concerning different options and trading off their features. This holds true for choices in pleasant contexts like choosing between different travel packages for a vacation, as well as more threatening contexts, like choosing between hospitals for minor surgery. For most adults, young or old, vacations are a time to which they are greatly looking forward, hoping to have a wonderful time, and hence spend some time planning this important time of the year. To do so, people gather and review information about different travel locations and hotels. Choosing at which hospital to undergo minor surgery is a very different yet no less relevant kind of decision. Although this may be a much less pleasant process, it requires for decision makers of all ages to gather and review information on different options. There is a growing interest in age-related changes in the decision-making process. This research has largely focused on implications of cognitive changes in old age, investigating the effect of older adults' decline in cognitive functioning on information processing and strategic decision-making (e.g., Mata, 2007; Mata et al., 2007; Sanfey & Hastie, 2000). However, there is also a number of "non-cognitive" factors that influence age-related differences in decision making such as emotional and motivational changes (e.g., Blanchard-Fields & Hess, 1999; Mather, 2006; Mather & Carstensen, 2005). We (Depping & Freund, 2011) have recently argued that older adults might become more sensitive to negative information when making a decision in order to avoid losses and negative outcomes. The current experiments investigate this hypothesis.

Motivational changes across adulthood. The decision-making literature acknowledges widely that the motivation and goals of the decision-maker are vital for understanding the decision-making process (e.g., Kahneman & Tversky, 1979; Hastie, 1991; Yates & Palatano, 1999). Hence, when investigating age-related differences in decision making, motivational changes may be an

important key. Two lines of research from the life-span developmental literature are particularly relevant in this regard. Probably the most prominent theory regarding motivational changes across adulthood is socioemotional selectivity theory (SST) by Carstensen and colleagues (e.g., Carstensen, et al., 1999). SST is based on the assumption that, due to their decreasing future time-perspective, older adults are primarily motivated to enhance their affective wellbeing. In contrast, younger adults, due to their extended future time-perspective, are primarily motivated to acquire information that might be of help to them later. In the more recent publications, SST has been applied to the so-called positivity effect in information processing. This effect denotes a preference for positive over negative stimuli in information processing (Reed & Carstensen, 2012). A growing literature suggests that older adults look longer at positive than negative stimuli and that they remember more positive or less negative emotional stimuli in experimental settings (e.g., Mather & Carstensen, 2003; Charles, Mather, & Carstensen, 2003). With respect to decision making, older adults attribute more positive features to the options they have chosen and more negative features to rejected options (Mather & Johnson, 2000) and report to be more satisfied with their choice when they explicitly evaluate the options previously (Kim et al., 2008). Moreover, older adults showed a more accurate recognition memory for positive features of choice options than for negative features, whereas younger adults showed equal accuracy for positive and negative information (Experiment 3, Mather, Knight, & McCaffrey, 2005). Note, that this does not reflect the overall memory for positive and negative information. Moreover, there was no age x valence interaction in *free recall* (Experiment 4A, Mather et al., 2005). As the free recall of choice features did not limit the memory test to a subset of presented material, one could argue that it allows for a more direct assessment of which choice features were encoded or retrieved from memory. Supporting the notion of an age-related positivity effect, Mather et al. (2005) found that older adults spent more time than younger adults to examine the positive attributes of different cars (Experiment 4B). Likewise, older adults viewed

proportionally more positive information on physicians and health plans (Löckenhoff & Carstensen, 2007, 2008). Importantly, in the study by Löckenhoff and Carstensen (2007) older adults did *not* show a positivity bias when focusing on the informational aspect of the stimuli. This finding indicates that the preference for positive stimuli and information in older adults might be modulated by their currently activated goals. In a similar vein, Reed and Carstensen (2012) recently argued, that task-dependent goals may supplant chronically activated present-oriented goals related to emotional gratification. We will elaborate more on this point below.

One of the key propositions of life-span psychology (Baltes, 1987) holds that development at all ages comprises both gains and losses. However, the ratio of gains to losses changes across the life span with losses becoming more and more predominant in old age (e.g., Baltes & Smith, 2003). Moreover, developmental tasks in young adulthood are primarily geared towards gains (e.g., attaining an education, getting a job, founding a family) whereas those in older adulthood reflect primarily the avoidance of losses (e.g., maintaining health-related and cognitive functioning in the face of age-related decline; Freund & Ebner, 2005). In the developmental phase of younger adulthood, then, attaining gains seems of primary importance in order to achieve developmental tasks and accumulate resources that are important for further development (Freund & Riediger, 2001). In contrast, the maintenance of functioning and avoidance of losses should become more important in older adulthood when losses in resources threaten functioning (Freund & Ebner, 2005). Supporting this hypothesis, Ebner et al. (2006) could show that goal orientation shifts from a predominant orientation towards gains in younger adults to an increasing orientation towards maintenance and the avoidance of losses in older adults. Moreover, this shift appears to be adaptive both for subjective wellbeing (Ebner et al., 2006) as well as for the persistence in goal pursuit (Freund, 2006). On the basis of this literature, we (Depping & Freund, 2011) have recently argued that the orientation towards prevention of losses may result in a higher sensitivity of older adults to negative

information when having to make a decision in order to prevent losses or negative consequences. There are currently no studies that directly test if older and younger adults differ in their processing of positive and negative information when they have to make a decision compared to other tasks. This was the primary aim of the present experiments.

Current Experiments

The current experiments tested whether age-related differences between young and older adults in their information processing of positive and negative information depend on the goal of information processing. We hypothesized that the positivity bias disappears when older adults use the information in order to make a decision. We used an incidental memory paradigm in order to investigate to which information (positive, negative, neutral) younger and older adults attend during the decision process. We contrasted the decision context with memory for the same information when it is evaluated regarding its readability (control condition). The study design extends previous studies in several ways: (a) It includes neutral information, (b) it directly assesses the memory for choice features by using a free-recall measure, (c) it contrasts information processing in a choice condition to information processing in a non-choice evaluation task. The latter extension allows comparing information processing in different tasks. Moreover, this design can ensure that potential memory effects in one condition are not simply driven by features of the material (that is identical in both conditions).

The two experiments contain choice scenarios in two different decision domains, namely travel and health. Whereas a choice between two vacation packages in Experiment 1 constitutes a positive situation for most people and might therefore trigger a preference for positive information, the choice between two hospitals for a minor surgery in Experiment 2 represents a more negative situation that should activate the motivation to avoid losses. Thus, we expected that the two choice scenarios differ with respect to overall focus on positive (Experiment 1) or negative information

(Experiment 2). The central question guiding both experiments is whether, regardless of a main effect of remembering more positive or negative information about the choice options, older adults are more likely to remember relatively more negative information compared to younger adults and compared to a situation that does not require a choice.

If the positivity effect is a general phenomenon in older adulthood, one would expect older adults to show this bias across different tasks and contexts. A stronger focus on positive information should result in better memory for positive information relative to negative and neutral information and relative to younger adults. In contrast, if older adults are more motivated to avoid losses than to achieve gains, one would expect them to be particularly sensitive to negative information when they have to make a decision that allows avoiding negative outcomes. Therefore, one would expect a better memory for negative information in the decision condition relative to the control condition and relative to younger adults.

Experiment 1

In Experiment 1, young and older adults read positive, negative, and neutral information about two travel options. All participants were asked to imagine that they were planning a vacation. By random assignment, they were either told that they will later choose between the two options (choice condition) or that they will later rate how well the texts were written (control condition). We expected differential effects of the condition on the recall of positive, negative, and neutral information. More specifically, we expected older adults to remember more negative information relative to other information presented, when they had to make a decision. Therefore, we operationalized this as the ratio of one valence category of information to all remembered information.

Method

Sample. A total of $N = 144$ younger and older adults participated in the experiment. One person had to be excluded due to a technical failure in saving the data. Five participants were excluded from the analysis because they did not remember any information on the travel packages, which clearly marked them as outliers. This resulted in a sample of $n = 66$ younger adults (19-30 years, $M = 24.02$, $SD = 2.71$; 65.2% female) and $n = 73$ older adults (60-88 years, $M = 71.09$, $SD = 4.82$; 59.7% female) who were all native German speakers.

The group of younger adults consisted primarily of undergraduate students (97%) and was recruited via a participant pool, flyers, or approached directly on the University campus. Older adults were recruited via the participant pool of our laboratory and by contacting churches (see Table 2 for further participant characteristics).

Procedure. Testing took either part in our laboratory or in a quiet room in a church and was done in small groups of one to six participants. Participants were randomly assigned to one of the two experimental conditions (see below). Upon arriving in the testing room, participants provided written informed consent. They then filled out a demographic questionnaire as well as a mood questionnaire. Subsequently, they were introduced to the experimental task described below. After the experimental task, we assessed their mood again. As a general verbal memory task, participants were then asked to learn and recall two word lists. The entire experimental session lasted approximately 30 minutes. After completing the experiment, participants were debriefed and received a monetary compensation of 10 Swiss Franks (equivalent to approximately 10 USD at the time of testing).

Table 2.

Participant Characteristics Experiment 1

	Younger group		Older group			
Measure	M	SD	M	SD	F(1,136)	p
Overall life satisfaction	4.53	.88	5.07	1.07	9.70	.002
Overall subjective health	4.71	.87	5.06	.87	4.86	< .05
VLMT	9.98	2.85	6.8	2.39	50.06	< .001
Remembered travel information	8.35	2.82	5.6042	1.93	42.37	< .001
MDBF pre-recall positive	3.83	1.03	4.40	1.24	8.54	.004
pre-recall negative	2.11	1.18	1.22	1.42	15.64	< .001
post-recall positive	3.86	.90	4.87	.78	28.75	< .001
post-recall negative	1.76	1.26	.81	.77	50.15	< .001
pre-recall	3.86	1.02	4.7257	1,59	12.38	.001
post-recall	4.05	1.0	5.03	.69	44.32	< .001
Education					89.13	< .001
Obligatory school	1.5		5.6			
Apprenticeship			25.0			
Upper professional training			27.8			
High school	74.2		6.8			
2 year college			18.1			
University degree	24.2		16.7			
Family status						
At least one child	0		83		97.31	< .001
In a stable relationship	45.5		63.9		4.73	< .05

Note. The VLMT measure reflects the average memory performance for two word lists. The MDBF measures are accessed by a short version of the Multidimensional Mood Questionnaire (MDBF) before and after the experimental task.

Design. The design was a 2 (age group: young, old) X 2 (experimental condition: readability, choice) X 2 (valence of remembered information: positive, negative) mixed factorial with age and condition as between-participant and valence of remembered information as within-participant factor. The dependent measures were (i) the amount of recalled positive and (ii) the amount of recalled negative information, operationalized as the ratio of positive or negative units of information remembered relative to the total number of information remembered.

Materials.

Travel information. We constructed two travel packages each containing three positive, three negative, and three neutral information units such as "*The rooms have paper-thin walls; we could often hear the people in the room next door.*" (negative), "*The hotel is located on a beautiful, wide sandy beach.*" (positive), or "*You are accommodated in a standard double room decorated in moorish style*" (neutral). The texts describing the two packages are provided in Appendix B. The travel packages were constructed on the basis of a pilot study. In this pilot study, younger (n = 72, M_{age} = 23.64 years) and older adults (n = 26, M_{age} = 70.31 years) rated the valence of travel-related information we had modeled after respective webpages featuring experiences of travelers such as TripAdvisor. We selected information that was rated as equally positive, negative, or neutral by both age groups. Information was categorized as positive, when the average rating was at least one SD above the grand mean of all items. Information was categorized as negative when the average rating was at least one SD below the grand mean of all items. Information was categorized as neutral when the average rating was within half a SD above or below the grand mean. On this basis, we constructed two packages that contained nine units of information (three positive, three negative, three neutral). In order to control for potential order effects of the information presented in the packages, we constructed four versions of each travel package varying the sequence of the presented information. Participants were randomly assigned to one of these packages.

Incidental Memory Task. Participants were instructed to imagine planning a vacation and to review information on two travel packages to the same destination (a fictional island called "Halukita"). They were told that the prize of these packages does not differ. In the *choice condition*, participants were informed that they have to choose between the two options. In the readability condition, participants were asked to rate the readability of the texts. The verbatim instructions of the two conditions are provided in Appendix A. Order of the two travel packages was randomized across participants. Reading was self-paced. After reading both texts, participants in the choice condition reported which of the two packages they chose, whereas participants in the control condition rated the readability of the texts. Afterwards, participants were engaged in a filler task (i.e., an unrelated personality questionnaire) of about 7 minutes, and were then asked to remember as much information from the travel packages as possible. Participants wrote down the information without matching them to the respective packages.

Ratings of recalled information. Two independent raters who were blind to participants' age or condition rated whether the remembered information matched the information in the travel packages. One point was given for each correctly remembered unit of information. Hence, there was a maximum of 18 points for the two travel packages. Interrater reliability was satisfactory, Cohen's Kappa = .93. As a conservative way of resolving discrepancies between the two raters, the analyses of the free recall data are based on the mean rating across both raters.

Mood. In the beginning of the session and after the free recall task, we assessed participants' mood. This measure was included to test if mood might affect the memory for positive or negative information, and if memory for more positive or negative information affects subsequent mood, respectively. Mood was assessed using the brief version of the Multidimensional Mood Questionnaire (Steyer, Schwenkmezger, Notz, & Eidt, 1997). This questionnaire consists of 12 emotion adjectives for which participants indicated on a scale from 0 (not at all) to 6 (very much)

how well they described their current mood. The scale can be aggregated into two scores indicating positive or negative mood, respectively. Cronbach's Alpha was .87 for positive and .88 for negative mood.

Memory. We assessed memory with an adapted version of the verbal learning and memory test (Helmstaedter, Lendt, & Lux, 2001). Participants were asked to memorize a list of 20 words. They then had to repeat the same procedure with a different list of words. Older adults remembered on average fewer words than young adults (see Table 2). The memory performance of participants did not differ between the two conditions, $F(1,136) = 1.57$, $p = .21$, and there was no significant condition x age group interaction $F(1, 136) = 3.22$, $p = .08$.

Health and life satisfaction. We assessed overall life satisfaction status with one item asking participants to rate their overall satisfaction, and subjective health with one item asking participants to rate their overall health. Both items were rated on a scale from 0 (very bad) to 6 (very good). Older adults reported overall higher life satisfaction and subjective health compared to younger adults (see Table 2).

Results

Preliminary Analyses.

Mood. Replicating earlier findings on mood in older adults (e.g., Mroczek & Kolarz, 1998), older adults reported overall higher positive and lower negative mood than younger adults at both measurement occasions (see Table 2). As mood might influence memory (e.g., Bower, 1981), we analyzed whether mood at baseline was associated with memory for positive or negative information in the choice options. Neither positive nor negative mood were significantly correlated with memory for positive or negative information, respectively (see Table 3). Reversing the potential causal relation between memory and mood, one could also hypothesize that remembering more positive or negative information influences the subsequent mood. In this case, there should be an

association between memory for positive and negative information and mood assessed *after* the memory task. Although there were no significant correlations between memory for positive or negative information and positive and negative mood (assessed after the memory task, see Table 3), memory for negative information was related to *change* in negative mood (i.e., difference between negative mood before and after the experimental task). However, counter to the expectation that negative memories might increase negative mood, participants who remembered more negative information experienced a *decrease* in negative mood. There were no significant relations of memory for negative information and change in positive mood or memory for positive information and change in positive mood or negative mood (see Table 3). Overall, then, the current experiment provides little support for the notion that remembering positive or negative information constitutes an effective emotion-regulation strategy.

Free Recall. Conforming with the literature on age-related differences in memory performance (e.g., Li et al., 2004), older adults remembered overall fewer units of information than younger adults (young: $M = 8.35$, $SD = 2.82$, older adults: $M = 5.60$, $SD = 1.93$, $t(136) = 6.72$, $p < .001$). Thus, we used a ratio of recalled positive information relative to all recalled units of information and a ratio of recalled negative information relative to all recalled information (note, that the two ratios are independent of each other as a third of the information in the vignettes was neutral). The two variables were negatively correlated, $r = -.34$, $p \leq .001$. A t-test revealed that there were no differences in total recall by condition, $t(136)=.21$, $p = .84$.

Table 3

Pearson Product-Moment Correlations Between Mood Before and After the Experimental Task and Memory for the Ratio of Positive and Negative Information to Total Information Remembered

Measure	1	2	3	4	5	6	7	8
1. MDBF baseline positive	-	-.80**	.71**	-.61**	.57**	-.37**	.09	.00
2. MDBF baseline negative		-	-.58**	.63**	-.45**	.60**	-.07	.07
3. MDBF post-recall positive			-	-.72**	-.16	.02	.15	.04
4. MDBF post-recall negative				-	-.02	-.24**	-.07	-.09
5. Mood change positive					-	-.54**	-.03	-.05
6. Mood change negative						-	-.01	.18*
7. Memory positive information							-	-.34**
8. Memory negative information								-

Note. Memory for positive and negative information is operationalized as the ratio of positive and negative information to total information remembered.

** p < .001 (2-tailed); * p < .05 (2-tailed).

Main Analyses.

Free Recall. A 2 (condition: decision, control) by 2 (age group: young, old) repeated measures analysis of variance was conducted to test the impact of the two conditions and the age group on the ratio of freely recalled positive and negative information. The interaction between valence of the information (positive vs. negative ratio of recalled information) and condition was not significant ($F(1,134) = 2.40$, $p = .12$, $\eta_p^2 = .02$, but the interaction between valence and age group reached marginal significance ($F(1,134) = 3.55$, $p = .06$, $\eta_p^2 = .03$). There was no main effect for valence ($F(1, 134) = .82$, $p = .37$) but a main effect for age group $F(1,134) = 20.55$, $p < .005$, $\eta_p^2 = .13$ and for condition $F(1, 134) = 9.72$, $p < .005$, $\eta_p^2 = .07$.

Qualifying these main effects and lower-order interactions and supporting our hypotheses, there was a significant interaction of condition, age group, and valence, $F(1, 134) = 5.12$, $p < .05$, $\eta_p^2 = .037$. Replicating earlier findings in the literature on the positivity effect, older adults remember more positive information than younger adults in the control condition (see Figure 3), $t(68) = -4.01$, $p < .01$. Young and older adults' memory for negative information does not differ significantly in the control condition, $t(68) = .95$, $p = .35$. In line with the hypothesis of an increase in the importance of negative information in older adulthood when making a decision, the effect reversed in the decision-making condition. As can be seen in Figure 3, when participants were asked to make a decision about which of the two presented vacation packages to choose, older adults recalled more negative information (relative to the total amount of recalled information) than young adults, $t(66) = -2.15$, $p < .05$. Young and older adults did not significantly differ in memory for positive information in the choice condition, as revealed by a t-test corrected for inequality of variances $t(57.59) = -1.79$, $p = .09$. Additionally, older adults recalled more negative information in the choice condition compared to the control condition, $t(70) = -3.52$, $p < .05$, but there was no difference for positive information, $t(70) = 0.74$, $p = .47$. Younger adults' memory for positive information did not differ between the two tasks, $t(64) = -1.56$, $p = .12$, nor did younger adults' memory for negative information, $t(64) = -.61$, $p = .55$.

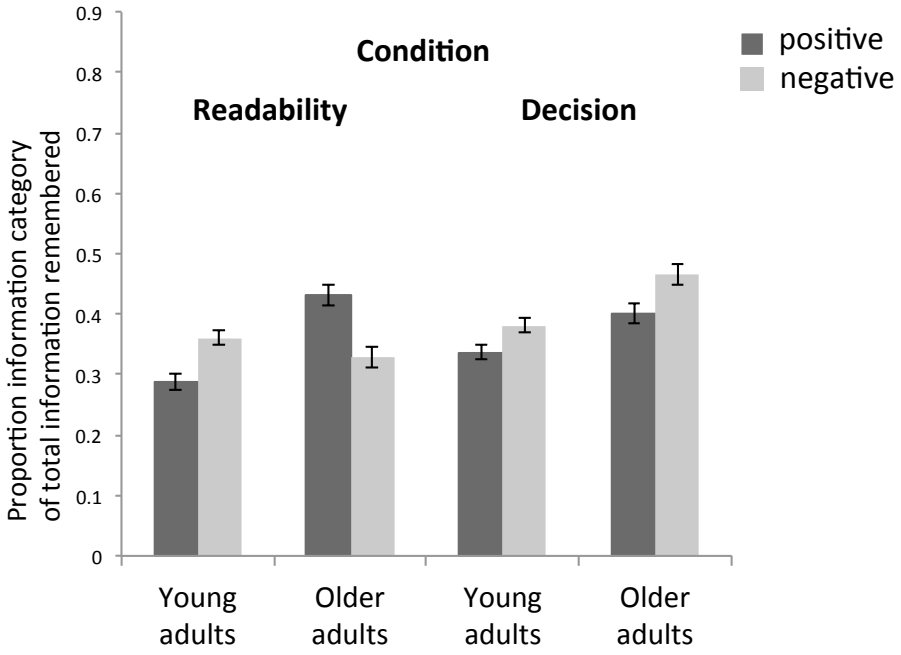

Figure 3. Experiment 1: Mean ratio of positive information to total information remembered and mean ratio of negative information remembered to total information remembered for young and older adults in the control condition and the choice condition. Error bars represent within-participant confidence intervals

Choice supportive memory bias. Valence asymmetries in the recollection of information on choice options could emerge from a choice supportive memory bias which should lead to more positive information recalled for the chosen option and / or more negative information for the rejected option. To quantify how much information participants remembered in the choice condition depending upon the chosen option, we calculated a choice supportive memory bias score by subtracting the recalled information in favor of the non-chosen option from the information recalled favoring the chosen option:

(recalled positive information on chosen option + recalled negative information on rejected option) –

(recalled negative information on chosen option + recalled positive information on rejected-chosen option)

The resulting choice supportive memory score ranges between -6 (in the case that a participant has remembered only information in favor of the rejected option) and +6 (in the case that a participant has remembered only information in favor of the chosen option). A negative score represents a memory bias in favor of the rejected option, a positive score a memory bias in favor of the chosen option. Given the equal distribution of positive and negative information for both options presented in the text, a choice supportive memory score of zero represents no memory bias in favor of any of the two options. The choice supportive memory score was on average -0.03 (SD = 1.84) for young adults and -0.44 (SD = 1.31) for older adults. A t-test adjusted for inequality of variances revealed that young and older adults' choice supportive memory score did not differ significantly, $t(55.38) = 1.21$, $p = .23$. Furthermore, the mean choice supportive memory score did not differ significantly from zero, $t(67) = -1.15$, $p = .26$. Thus, on average the recall of information on the two choice options was not biased in favor of any of the two options.

Brief Discussion of Experiment 1

Experiment 1 presents first evidence that choice matters for age-related differences in information processing: When having to make a decision (here: between vacation packages), older adults showed a better memory for negative information relative to positive information and relative to younger adults. In contrast, when no decision is required, older adults remembered positive information better.

This pattern of results supports the notion that older adults are more motivated to avoid negative outcomes and losses than younger adults (Freund, 2006; Ebner et al., 2006; Staudinger et al., 1995) in the context of decision making (Depping & Freund, 2011). The positivity effect (i.e., better memory for positive information) in older adults was found only when the valence of the

provided information was irrelevant to the task (i.e., evaluating the readability of vacation descriptions). This condition resembles earlier research in the tradition of the positivity effect that used memory for positively or negatively valenced images (Charles et al., 2003) or advertisements (Fung & Carstensen, 2003) when no task was specified (i.e., passive viewing). This effect is typically interpreted as a demonstration of a general bias towards positive information in older adulthood. However, results of Experiment 1 suggest that decision making is associated with better memory for negative information relative to positive and neutral in older adults.

This effect suggests that information processing depends on the person's goals. In the current experiment, the goal in one condition was to choose between two vacation packages, very likely a decision with which both younger and older adults are familiar. As probably both young and older adults know, making a bad decision about a vacation package can have unpleasant consequences such as ending up at an inconveniently located, noisy, or dirty hotel. Thus, if the goal is to avoid such bad outcomes, it makes sense to pay particular attention to information that indicates potential problematic aspects of an option. Older adults seem to do this more than younger adults. Based on research on goal orientation (Ebner et al., 2006), we interpret this finding as reflecting a higher sensitivity to information signaling bad outcomes or losses in older compared to young adults.

One alternative explanation of this pattern of results is that the decision task was cognitively more demanding than the readability evaluation task (control condition). Mather and Knight (2005) have reported that the positivity effect reverses when a task places high demand on older adults' cognition. Thus, one of the aims of Experiment 2 was to address this question directly by asking participants as how demanding they experienced the two tasks.

Moreover, Experiment 1 did not assess the alignability of the features presented in the two different vacation packages. Alignability might play a major role for free recall as recalling a specific

feature of one option might enhance the likelihood of recalling the respective feature of the second option. Thus, the material of Experiment 2 was designed to address this issue.

Experiment 2

Experiment 1 supports the idea that older adults process information differently when a decision is required than in other tasks. Moreover, in a choice context, they remember more negative than positive information. In order to generalize this finding to other decision domains, we ran another experiment in the health domain—a decision domain that is highly relevant to both age groups. In Experiment 2, participants were asked to imagine that they had to undergo a minor surgery at a hospital. This prospect is likely to be unpleasant for both age groups and even a minor surgery entails some health-related risks, thereby potentially triggering an orientation towards the avoidance of losses. Thus, Experiment 2 allows comparing young and older adults' information processing in an overall negative decision context. We expected to replicate findings of Experiment 1, namely that older adults remember more negative than positive information in the decision condition compared to the control decision and compared to younger adults. Because of the overall negative nature of the scenario, we expected younger and older adults to remember more negative information relative to other information in both conditions. Experiment 2 further extends Experiment 1 in that all participants went through both experimental conditions and later compared the tasks in difficulty and easiness. This allows investigating whether one of the two tasks is more cognitively demanding than the other. As a surprise memory test can only be surprising once and the material was learned and retrieved before, there was no memory test in the second task.

Method

Sample. A total of $N = 122$ younger and older adults participated in the experiment. This resulted in a sample of $n = 62$ younger adults (18 – 31 years, $M = 24.11$, $SD = 2.97$; 62.9% female) and $n = 60$ older adults (64 - 86 years, $M = 73.01$, $SD = 4.86$; 61.7% female) who were all native

German speakers. The group of younger adults consisted primarily of undergraduate students (93.5%) and was recruited via a participant pool, flyers, or approached directly on the University campus. Older adults were recruited via the participant pool of our laboratory (see Table 4 for further participant characteristics).

Procedure. Testing took part in a quiet computer laboratory and was done in small groups of one to nine participants. The experimental procedure was identical to the one in Experiment 1 with one extension, namely that all participants did both tasks (choice and readability evalution). The order of the tasks was counterbalanced. The free recall test was given after the first task. After the post-free recall mood measure, participants worked on the second task. Participants in the decision condition where asked as a second task to read the texts again in order to rate their readability and, vice versa, participants who first rated the readability received the choice task second. Subsequently, participants rated the difficulty and easiness of the two tasks. This rating was followed by a final assessment of mood. Finally, participants were asked to learn and recall two word lists. The entire experimental session lasted approximately 30 minutes. After completing the experiment, participants were debriefed and received a monetary compensation of 10 Swiss Franks (equivalent to approximately 10 USD at the time of testing).

Design. The design was a 2 (age group: young, old) X 2 (experimental condition: readability, choice) X 2 (valence of remembered information: positive, negative) mixed factorial with age and condition as between participant and valence of remembered information as within-participant factor. As in Experiment 1, dependent measures were (a) the amount of recalled positive and (b) the amount of recalled negative information, operationalized as the ratio of positive or negative units of information remembered relative to the total number of remembered information.

Table 4

Participant Characteristics Experiment 2

	Younger group		Older group			
Measure	M	SD	M	SD	F(1,120)	p
Overall life satisfaction	5.74	.85	6.13	.70	7.69	<.01
Overall subjective health	5.66	1.02	5.57	.99	.267	n.s.
VLMT	9.67	3.18	5.24	2.62	69.94	<.001
Remembered hospital info.	7.51	2.33	4.02	2.23	71.51	< .001
MDBF pre-recall positive	5.10	.87	5.74	.81	17.33	<.001
pre-recall negative	2.41	.74	1.67	.87	25.75	< .001
post-recall positive	4.89	.78	5.99	.78	58.51	< .001
post-recall negative	2.25	.77	1.81	.96	8.25	< .01
Education					59.16	< .001
Obligatory school	3.2		10			
Apprenticeship	6.5		28.3			
Upper professional training			13.3			
High school	54.8		10			
2 year college			21.7			
University degree	35.5		23.3			
Family status						
At least one child	0		81.7		84.62	< .001
In a stable relationship	32.2		60		86.19	< .001

Note. The VLMT measure reflects the average memory performance for two word lists. The MDBF measures are accessed by a short version of the Multidimensional Mood Questionnaire (MDBF) before and after the experimental task.

Materials. In Experiment 2, participants reviewed information on hospitals and included a comparison of the difficulty of the two tasks. All other scales were identical to Experiment 1.

Hospital information. We constructed two hospital options each containing three positive, three negative, and three neutral information units such as "*The entire house was dirty and untended.*" (negative), "*The doctors were friendly and understanding.*" (positive), or "*The waiting room was next to the*

information desk." (neutral). The texts describing the two packages are provided in Appendix D. The hospital options were constructed on the basis of two pilot studies. In the first pilot study, younger (n = 83, M_{age} = 24.99 years) and older adults (n = 93, M_{age} = 68.58 years) rated the valence and importance of 100 statements on hospitals on a 7-point Likert scale. Importance was defined as how important/critical this information was to them in case they would review this information when choosing for or against a hospital with this feature. The information was taken from actual patient experience reports that were published on a Swiss homepage on which patients exchange their experiences with specific hospitals (similar to a TripAdvisor for hospitals). We categorized information as positive when their mean rating was one standard deviation above the mean valence rating across all information. We categorized information as negative when it was one standard deviation below the mean valence rating across all information. Information was categorized as neutral when its mean rating was within half a standard deviation above or below the grand mean of all information. We then selected information that was rated as equally positive, negative, or neutral as well as equally important by both age groups. On the basis of the results of this first pilot study, we conducted a second pilot study, in which young and older adults rated the pre-selection of information on the dimensions arousal (N = 63), vividness (N = 60) and complexity (N =64) of the information. We then selected information that showed no age-related differences regarding these dimensions.

Finally, we constructed two packages that contained nine units of information (three positive, three negative, three neutral). Information on the two hospitals was provided on unrelated aspects in order to control for alignability. In order to control for potential order effects of the information presented in the packages, we constructed four versions of each travel package varying the sequence of the presented information. Participants were randomly assigned to one of these packages.

Incidental Memory Task. Participants were instructed to imagine that they were choosing a hospital for a minor surgery and reviewed information on two options. They were told that their insurance would cover the full costs at either of the two hospitals. As in Experiment 1, there were two conditions. In the *choice condition*, participants were informed that they had to choose between the two options. In the readability condition, participants were asked to rate the readability of the texts (see Appendix C for the verbatim instruction). The order of the two hospitals was randomized across participants. Reading was self-paced. After reading both texts, participants in the choice condition reported which of the two hospitals they chose, whereas participants in the control condition rated the readability of the texts. Afterwards, participants were engaged in a filler task in which they filled out an unrelated personality questionnaire that took about 7 minutes, and were then asked to remember as much information from the hospitals as possible. Participants wrote down the information without matching them to the respective packages.

Comparison of difficulty and easiness. After completing both tasks, participants were asked to rate how the two tasks compared in difficulty on a 7-point scale ranging from "choice clearly harder" (0) to "readability clearly harder" (6). Additionally, participants compared the task with respect to easiness, on a 7-point scale from 0, "choice clearly easier" to 6 "readability clearly easier." The mid-point of the scale (=3) represented equal difficulty/ easiness of both tasks.

Ratings of recalled information. Two independent raters who were blind to participants' age or condition rated whether the remembered information matched the information in the hospital options. One point was given for each correctly remembered unit of information. Hence, there was a maximum of 18 points for the two travel packages. Interrater reliability for positive, negative and neutral information was satisfactory, Cohen's Kappa = .87. Again, the analysis of free recall is based on the mean of both raters.

Results

Preliminary Analyses.

Mood. As in Experiment 1, older adults reported overall higher positive and lower negative mood than younger adults at both measurement occasions (see Table 4). Again, we analyzed whether baseline mood was associated with memory for positive or negative information in the choice options. Replicating the findings of Experiment 1, neither positive nor negative mood were significantly correlated with memory for positive or negative information, respectively (see Table 5). Furthermore, there was no significant association between memory for positive and negative information and mood assessed *after* the memory task. Unlike in Experiment 1, memory for negative information was not related to *change* in negative mood (i.e., difference between negative mood before and after the experimental task). There were no significant associations of memory for negative information and change in positive mood or memory for positive information and change in positive mood or negative mood (see Table 5). Overall, then, Experiment 2 also provides little support to the notion that remembering positive or negative information constitutes an effective emotion-regulation strategy.

Free Recall. Replicating Experiment 1 and previous findings (e.g., Li et al., 2004), older adults remembered overall fewer units of information than younger adults (young: $M = 7.51$, $SD = 2.33$, older adults: $M = 4.02$, $SD = 2.23$, $t(120) = 8.45$, $p < .001$). Thus, we again used a ratio of recalled positive information relative to all recalled units of information and a ratio of recalled negative information relative to all recalled information. There was a negative correlation between the two variables, $r = -.64$, $p \leq .001$. As in Experiment 1, there were no differences in total recall by condition, $t(120) = .63$, $p = .53$.

Table 5

Pearson Product-Moment Correlations Between Mood Before and After the Experimental Task and Memory for the Ratio of Positive and Negative Information to Total Information Remembered

Measure	1	2	3	4	5	6	7	8
1. MDBF baseline positive	-	-.58**	.70**	-.46**	.32**	-.15	.04	.08
2. MDBF baseline negative		-	-.58**	.65**	.06	.42**	-.03	.05
3. MDBF post-recall positive			-	-.72**	-.45**	.08	-.09	.05
4. MDBF post-recall negative				-	.29**	-.42**	-.07	-.09
5. Mood change positive					-	-.54**	.003	-.02
6. Mood change negative						-	.06	-.003
7. Memory positive information							-	-.63**
8. Memory negative information								-

Note. Memory for positive and negative information is operationalized as the ratio of positive and negative information to total information remembered.

** p < .001 (2-tailed).

* p < .05 (2-tailed).

Main Analyses.

Free Recall. A 2 (condition: decision, control) by 2 (age group: young, old) repeated measures analysis of variance was conducted to test the impact of the two conditions and age group on the ratio of freely recalled positive and negative information. The interaction between valence of the information (positive vs. negative ratio of recalled information) and condition was significant ($F(1,118) = 8.44$, $p < .01$, $\eta_p^2 = .07$) as was the interaction between valence and age group ($F(1,118) = 7.46$, $p < .01$, $\eta_p^2 = .06$). There was a main effect for valence ($F(1,118) = 115.41$, $p < .001$, $\eta_p^2 = .49$) and age group ($F(1, 118) = 5.28$, $p < .05$, $\eta_p^2 = .04$) but not for condition ($F(1, 118) = .16$, $p =$

.67, η_p^2 = .001). The three-way interaction of condition, age group, and valence was not significant, $F(1, 118) = 2.19$, $p = .14$, $\eta_p^2 = .02$.

As can be seen in Figure 4, young and older adults' memory for positive information ($t(60) = .07$, $p = .94$) and negative information ($t(60) = -1.33$, $p = .19$) did not differ in the control condition. However, in the choice condition older adults remembered more negative information than younger adults, t-test adjusted for inequality of variances $t(40.70) = -3.13$, $p < .01$. Furthermore, older adults remembered less positive information than younger adults, $t(58) = 2.45$, $p = .05$. Comparisons between the conditions revealed that older adults remembered less positive ($t(46.41) = 2.39$, $p < .05$) and more negative information ($t(58) = -1.97$, $p = .05$) in the choice condition compared to the control condition.

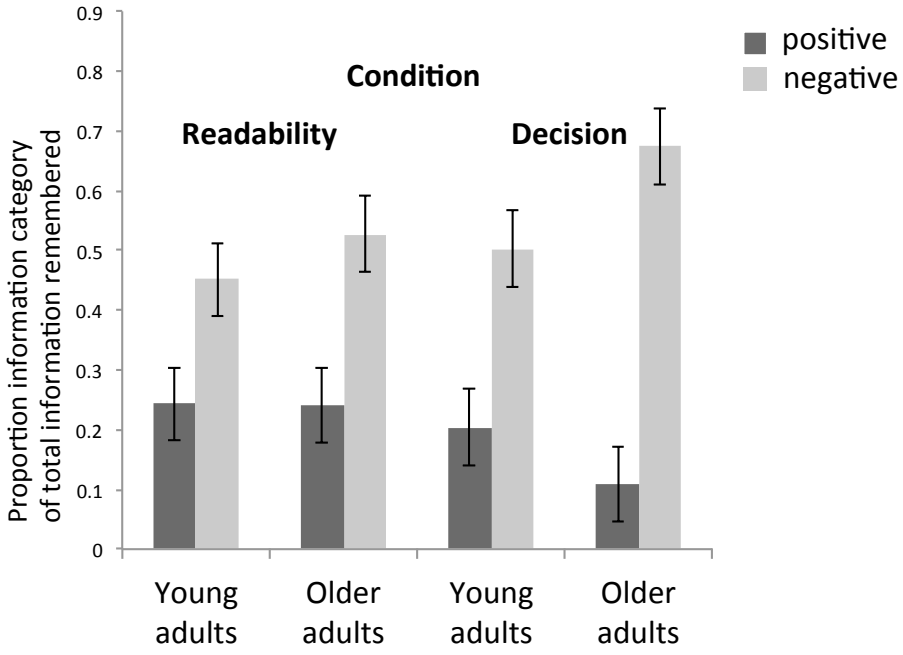

Figure 4. Experiment 2: Mean ratio of positive information to total information remembered and mean ratio of negative information remembered to total information remembered for young and older adults in the control condition and the choice condition. Error bars represent within-participant confidence intervals

In sum, young and older adults remembered more negative information relative to other information in both conditions. In line with the hypothesis of an increased importance of negative information in older adulthood when making a decision, older adults remembered more negative information and less positive information than young adults in the decision condition. Additionally, when older adults were asked to make a decision about which of the two hospitals to choose, they recalled more negative information (relative to the total amount of recalled information) and less positive information than in the control condition.

Choice supportive memory bias. As in Experiment 1, we calculated a choice supportive memory bias score. Young and older adults did not differ on their average choice supportive memory score (young: -0.02 (*SD* = 1.34), old: -0.18 (*SD* = 1.11); $t(58) = .52$, $p = .60$). Furthermore, the choice supportive memory score was not significantly different from zero, $t(59) = -.63$, $p = .53$. In other words, neither young nor older adults showed a choice supportive memory bias.

Difficulty. Extending Experiment 1, participants worked on both tasks to later compare them regarding their difficulty and easiness. T-tests showed that young and older adult's rating of difficulty did not differ significantly (young: *M* = 2.15, *SD* = 1.89; old: *M* = 1.93, *SD* = 1.76), $t(120) = .64$, $p = .52$. Likewise, the age groups did not differ regarding the easiness ratings of the two tasks (young: *M* = 3.63, *SD* = 2.15; older: *M* = 3.08, *SD* = 2.27), $t(120) = 1.36$, $p = .18$. We therefore collapsed the ratings of young and older adults to analyze whether the mean ratings significantly differed from the mid-point of the scale (indicating equal difficulty and easiness for both tasks). The mean rating for difficulty significantly differed from the mid-point of the scale, $t(121) = -5.81$, $p < .001$. With a mean rating of *M* = 2.04 (*SD* = 1.83) participants rated the decision task to be more difficult than the control task. The mean rating for easiness (*M* = 3.36, *SD* = 2.22) did not significantly differ from the mid-point of the scale, $t(121) = 1.79$, $p = .08$, indicating that the two tasks were rated equally easy.

In order to control for the task difficulty, we entered task difficulty as a covariate in the main analysis of free recall. The covariate reached only marginal significance, $F(1,117) = 3.70$, $p = .06$, $\eta_p^2 = .03$. More importantly, the pattern of results remained as reported above. There was a significant main effect of valence, $F(1,117) = 64.74$, $p < .001$, $\eta_p^2 = .36$ and a significant effect of age $F(1,117) = 5.91$, $p < .05$, $\eta_p^2 = .05$. These main effects were qualified by a significant age x valence interaction, $F(1,117) = 7.09$, $p < .01$, $\eta_p^2 = .06$, and a significant valence x condition interaction, $F(1,117) = 8.59$, $p < .01$, $\eta_p^2 = .07$. The three-way interaction of valence x age x condition did not reach significance, $F(1,117) = 2.66$, $p = .11$, $\eta_p^2 = .02$. These results suggest that, although task difficulty was higher for the decision task, the findings are unaffected when controlling for difficulty. In other words, there is no reason to believe that the age-related effects of task on the amount of negative information remembered are driven by a task-related difficulty.

Comparison of both experiments. In order to test whether the two experiments differed with respect to memory for positive and negative information, we collapsed both datasets and ran a 2 (experiment: travel, hospital) x 2 (condition: decision, control) by 2 (age group: young, old) repeated measures analysis of variance. The interaction between valence of the information (positive vs. negative ratio of recalled information) and experiment was significant, $F(1,252) = 72.96$, $p < .001$, $\eta_p^2 = .23$. As can be seen when comparing Figure 3 and Figure 4, young and older adults remembered overall more negative information in Experiment 2 compared to Experiment 1. Furthermore, the interaction between valence of the information and condition was significant, $F(1,252) = 11.28$, $p < .01$, $\eta_p^2 = .04$. The interaction between valence and age group did not reach significance, $F(1,252) = 1.52$, $p = .22$, $\eta_p^2 = .00$. In other words, the age groups did not differ in memory for positive and negative information when condition is not taken into account. There was no main effect for experiment, $F(1, 252) = 0.27$, $p = .61$. Furthermore, there was a main effect for

valence ($F(1, 252) = 91.06$, $p < .001$, η_p^2 =), a main effect for age group ($F(1, 252) = 22.42$, $p < .001$, $\eta_p^2 = .08$) and for condition ($F(1, 252) = 5.60$, $p < .05$, $\eta_p^2 = .02$). Qualifying these main effects and lower-order interactions and in line with our hypotheses, across both experiments there was a significant interaction of condition, age group, and valence, $F(1, 252) = 6.48$, $p < .05$, $\eta_p^2 = .03$. Thus, although young and older adults remembered more negative information in Experiment 2 overall, the expected pattern of results was stable across both experiments. Furthermore, there was a significant interaction of valence, experiment and age group, $F(1,252) = 11.30$, $p < .01$, $\eta_p^2 = .04$. The interaction of valence x experiment x condition did not reach significance, $F(1, 252) = 2.34$, $p = .13$, nor did the interaction of valence, experiment, age group and condition, $F(1,252) = 0.003$, $p = .96$.

Brief Discussion of Experiment 2

The objective of Experiment 2 was to replicate the finding of Experiment 1 that the requirement to make a decision increases memory for negative information in older but not in younger adults. Furthermore, Experiment 2 aimed at extending the findings of Experiment 1 by investigating information processing in a negative or even somewhat threatening context that is likely to activate an orientation towards the prevention of losses. Additionally, a within-participant comparison of the difficulty and easiness of the two tasks (choice vs. control task) was added to allow controlling for potential effects of task difficulty. As expected for the negative context of having to undergo minor surgery, both age groups remembered more negative than positive information of the texts regardless of experimental condition. Further conforming our hypothesis, older adults remember more negative information in the choice compared to the control condition and compared to young adults. Moreover, older adults remembered less positive information compared to the control condition and compared to young adults in the choice condition.

General Discussion

Do young and older adults differ in the way they process positive and negative information? Two experiments suggest that age-related differences in memory for valenced information depends on the task at hand. We expected – and found - age-related differences in the memory for negative information in a decision-making task. This expectation was based on previous findings of an increased goal orientation towards the prevention of loss across adulthood (Depping & Freund, 2011; Ebner et al., 2006; Freund, 2006).

The current experiments used an incidental memory paradigm for information reviewed either after having had to choose between the two options or when after having had to rate how well the texts are written (control condition). This design allowed comparing memory for positive and negative information after information processing for different purposes. In Experiment 1, participants read information on travel packages. Confirming earlier findings on the positivity effect, older adults remembered more positive information than young adults but did not differ in the amount of remembered negative information in the control condition (e.g., Charles et al., 2003). However, this pattern reversed in the choice condition. Here, older adults remembered more negative information than young adults. Furthermore, older adults recalled more negative information in the choice than in the control condition. This pattern of results supported our hypothesis, that older adults focus more on negative aspects when making a decision. Based on the goal-orientation literature, we assume that this is the case because older adults are more motivated to avoid negative outcomes than younger adults.

In Experiment 2, participants read information on hospitals in a hypothetical situation of having to undergo minor surgery. Because this is a more threatening context compared to planning a vacation, we expected and found a stronger overall focus on negative information. More importantly in the present context and replicating results of Experiment 1, older adults remembered

more negative information and less positive information compared to young adults in the choice condition and compared to the control condition. We interpret this finding as supporting our main hypothesis that older adults are more motivated to avoid losses than younger adults. However, an alternative explanation could be that the pattern of findings is due to higher cognitive demands of the choice task compared to the task of evaluating the readability of the texts. In fact, Knight et al. (2007) and Mather and Knight (2005) showed that the positivity effect could be reversed under conditions of high cognitive load. Thus, rather than reflecting a heightened sensitivity to loss and negative information, it is possible that older adults have to exert more cognitive control in the choice condition relative to the condition in which they are assessing readability. To address this question we assessed the subjective difficulty of the decision and the control task. Speaking against the cognitive load explanation, the pattern of results was maintained when statistically controlling for task difficulty. Further contradicting the cognitive load explanation is that total recall did not differ by condition in both experiments.

A second alternative interpretation of our results could be that better memory for negative features is driven by a choice-supportive memory bias (i.e., a memory bias that favors negative information on the non-chosen option). However, this does not seem to be the case as neither young nor older adults showed a choice supportive memory bias in either of the two experiments.

A third explanation of the pattern of findings is that mood might have directed attention and memory. This explanation was not supported in the current experiments, as there were no associations between mood at baseline and memory for either positive or negative information.

A fourth possible interpretation of the pattern of findings (particularly of Experiment 1) draws on the control-dependency principle formulated by Rothermund (2011). According to this principle, information processing is characterized by a focus on negative information ("problem focus") if goal pursuit is experienced as controllable. In contrast, experiencing a lack of control over

important outcomes is accompanied by a positivity bias ("enhancement focus"). One could argue that the very definition of a choice task is to give some degree of control to the decision maker who can accept or reject either of the options. In contrast, judging the readability of two text paragraphs provides no control over the (un)pleasantness of the described vacations or hospitals. Thus, the control condition might have elicited an "enhancement focus," whereas the decision context might have induced a "problem focus." However, this interpretation cannot account for the age-related differences that are at the core of our findings.

Finally, one could raise the concern that memory effects could be driven by characteristics of the material that have not been controlled for. However, main effects of such characteristics should occur in both experimental conditions.

Taken together, the results of both experiments support the hypothesis that, in the context of making a decision, older adults focus more on negative information compared to positive information and compared to younger adults. We interpret this as support for our age-related prevention of loss hypothesis (Depping & Freund, 2011). As a goal orientation towards the prevention of losses increases across adulthood, it is likely that older adults grow more sensitive to loss-related information when they have the means to control them. In the hypothetical choice scenarios, the positive and negative information presented had diagnostic value for subsequent outcomes: Ending up with a hotel that is dirty may ruin the vacation, choosing a suboptimal hospital for surgery might actually be life threatening. In contrast, when having to evaluate the readability of texts, the valence of the presented information is irrelevant. The only consequence the valence of the information might have is to affect the mood in the current situation. Note, however, that the amount of remembered positive information did not enhance participants' mood in the present studies.

Relation to previous studies on the positivity effect. To date, few studies have investigated age-related differences in memory for negative and positive choice features. Some studies investigated recognition memory accuracy for positive and negative information (e.g. Mather et al., 2005). To assess recognition memory, these studies presented half of the originally presented material (old) and the same amount of new information to measure how good young and older adults were at correctly recognizing positive and negative features as old. These studies found that older adults were more accurate in recognizing positive compared to negative information. However, these studies did not measure overall memory for positive and negative features and, therefore, cannot test age-related differences in the total of potentially remembered positive or negative information, respectively.

Theoretically, it is not clear how recognition memory accuracy relates to free recall. However, free recall is arguably the most direct assessment of what a person remembers about a given scenario and allows assessing memory for all previously presented material. There is only one published exception (Experiment 4A in Mather, et al., 2005) that used a free-recall measure. In this experiment, there was no age-difference in the recollection of positive and negative information and no bias towards any of the two types of information. Thus, we are not aware of any studies showing a positivity effect in overall memory for choice features in a decision context.

Using a different methodological approach, Mather et al., (2005, Experiment 4B) and Löckenhoff and Carstensen (2007, 2008) investigated the positivity effect in decision making using measures of information search and attention. Mather et al. (2005) used an information grid that allowed to sequentially review information on choice options. They found that older adults spend proportionally more time reviewing positive information than young adults and less time viewing negative information. In studies by Löckenhoff and Carstensen (2007, 2008), young and older adults worked with a similar information grid, in which young and older adults were asked to

sequentially search for information in order to make a decision. Participants saw color-coded boxes that covered either positive or negative information. These boxes revealed the information "very good" or "good" for the positive cases and "very bad" or "bad" in the negative cases. In the end, participants were asked to remember their chosen option and fill in the respective information in the grid. Here, older adults reviewed a greater proportion of positive than of negative information compared with young adults. This pattern reversed when they were instructed to focus on the informational aspect of the information. Furthermore, older adults remembered more positive than negative information compared with young adults when later filling in the cells of the information grid for their chosen option. This experimental approach allows investigating sequential information search when information is hidden. In contrast, our experiments do not investigate the search process but rather memory after reviewing all available information. Moreover, in the Löckenhoff and Carstensen studies participants were informed that certain features of the presented options were "good" or "bad," even if not uncovering them. If older adults are more sensitive to losses, one could argue that knowing an important feature is bad may be sufficient information for the decision maker and does not need to be uncovered. For instance, when cleanliness of a hotel or, even worse, a hospital is indexed as "bad," one does not necessarily need to know the details for this to be an important decision feature.

Although the methodological differences of the previously described and the current two studies render a comparison of the results difficult, one feature that is similar between all of these studies is that they refer to health-related choice contexts: Hospitals (current Experiment 2), physicians (Löckenhoff & Carstensen, 2007), and health-care plans (Mather et al., 2005; Löckenhoff & Carstensen, 2007). The current study may differ with respect to how near in time the (hypothetical) consequences would emerge. The scenario presented in Experiment 2 requires participants to imagine that they have to undergo minor surgery at a hospital. The decision

concerned the choice between two hospitals, not whether or not to undergo the surgery at all. Thus, the scenario required participants to imagine that the surgery was certain. In contrast, a health care plan may or may not be relevant in the future. Therefore, this context may be particularly sensitive to the limited time perspective of older adults that, according to socioemotional selectivity theory (SST) drives age-related differences in focusing on positive information. Supporting this notion, Löckenhoff and Carstensen (2007) showed that the positivity effect disappeared when statistically controlling for future time perspective. Many health-related decisions that older adults face nowadays require them to choose between options that are certain to affect them in the present, such as which treatment they want or which medication they prefer. Therefore, it is important to understand how older adults deal with potential losses in decisions that will likely affect them in the present.

Limitations. One limitation of the studies is that we did not assess the goals of participants directly, which would be helpful for investigating the link between goals and sensitivity towards positive and negative information. Note, however, that previous research has provided evidence that goals geared towards the attainment of gains or the prevention of losses do, in fact, influence information processing (Molden & Higgins, 2005).

Another limitation of the study is that we included a self-report measure for task difficulty. The within-subject difficulty comparison of the choice condition to the control condition presented a feasible attempt to control for potential effects of cognitive demand of the task on the memory pattern. However, perceived difficulty of the task and cognitive demand of the task may correspond only loosely.

Finally, the current state of the research leaves us with a puzzling discrepancy between studies investigating information search and memory assessed with free recall. Although methodological difficulties make it difficult to combine the methods (one can only remember

information one has actually looked at), future research is needed to reconcile these different findings.

Despite these shortcomings, the current experiments provide important new insights into the boundary conditions of the positivity effect in old age. The experiments presented here provide first support that older adults have a better memory for negative information than young adults when the information is relevant to a decision. We interpret the finding as supporting the age-related loss avoidance hypothesis: Older adults focus more on negative aspects in order to avoid losses.

CHAPTER III:

WHO IS AFRAID OF LOSSES?

DECISION MAKING IN ADOLESCENTS, YOUNG, AND OLDER ADULTS IN A NON-HYPOTHETICAL, NON-MONETARY GAMBLING TASK

Miriam K. Depping

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Abstract

Motivational life-span development suggests that a shift from a primary orientation towards attaining gains in adolescence and young adulthood to preventing losses in older adulthood. The current study tests if this motivational shift affects behavioral and emotional responses to risks as well as gains and losses. More specifically, we investigated adolescents (13- 17, *n* = 23), young (18-30, *n* = 42) and older (64-85, *n* = 43) adults' risk taking in a non-hypothetical, non-monetary gambling task with mixed gambles and in a series of hypothetical monetary gambles. Event-related heart-rate change and skin-conductance responses were analyzed in reponse to gains and losses in the gambles. Results indicate that older adults were more risk averse in their choices in the non-monetary gambles compared to adolescents and young adults, and that they showed stronger physiological reactions to losses compared to gains. Adolescents and young adults did not differ in behavioral responses but, unlike young adults, adolescents had stronger physiological responses to gains than to losses. Results partially confirm hypotheses derived from the motivational life-span developmental framework elaborated by Depping and Freund (2011).

Who is Afraid of Losses? Decision Making in Adolescents, Young, and Older Adults in a Non-Hypothetical, Non-Monetary Gambling Task

Decision making is central to everyday functioning at all ages, ranging from such mundane decisions as to what to wear today to more profound ones such as what profession to choose or when to retire. With changing developmental tasks, it is likely that the kinds of decisions change across the life span. For instance, in adolescence decisions may concern topics related to education, in young adulthood the areas of job choice and whether and with whom to start a family, and in older adulthood when to retire or when to move to senior housing (Freund & Baltes, 2005; Havighurst, 1972). In addition to the decision topics, there are likely to be age-related changes regarding the importance of potential gains and losses for the decision (Depping & Freund, 2011; Chapter II). Many decisions are made under uncertainty, that is, the decision involves a certain risk to bring about gains or losses but the exact likelihood is unknown to the decision maker. Are there systematic age-related differences in the emotional reactions to the risk of gains and losses across adulthood? To date, findings on age-related differences in risky choices are mixed. Moreover, most of this research only involves the comparison of two age groups (e.g., young vs. older adults). The present research aims at contributing to a better understanding of age-related differences in decisions involving risks by investigating non-hypothetical, non-monetary decisions between mixed gambles and emotional reactions to gains and losses.

The current research is based on motivational life-span developmental considerations (Depping & Freund, 2011). Because potential gains and losses associated with choices may have a differential impact on a decision depending on what the decision maker wants to achieve or avoid in a given situation, motivational development may provide an important new perspective on age-related changes. As goal orientation changes across the life span

from a predominant orientation towards achieving gains to a stronger orientation towards preventing of losses (Ebner et al., 2006; Freund, 2006; Mustafic & Freund, 2012; Staudinger et al., 1995), decision makers may process information on gains and losses differently at different ages (Depping & Freund, 2011). For example, adolescents are more likely to maximize immediate positive consequences (e.g., Reyna & Farley, 2006), displaying high approach and low avoidance orientation (Cauffman et al., 2010; Somerville, Jones, & Casey, 2010). Similarly, young adults are primarily oriented towards growth, whereas the prevention of loss becomes increasingly important in old age when resources are more limited than at younger ages and losses abound (Ebner et al., 2006; Freund, 2006). This shift in goal orientation may lead to systematic age-related differences in a focus on potential positive consequences of a decision compared to the avoidance of potential negative consequences. In line with the findings on goal orientation, we assume that there may be a shift in decision making under risk from a primary salience of potential gains (relative to potential losses) in adolescence and young adulthood to an increasing salience of potential losses (relative to potential gains) in older adulthood.

A change in the impact of gains and losses on decision making should be reflected in descriptive accounts of decision-making *behavior* (Kahneman & Tversky, 1979). We hypothesize that the shift in goal orientation from gains to the prevention of loss translates into an increase in risk aversion from adolescence to old adulthood. Following this reasoning, the guiding question of the current study is if there are age-related differences in adolescents', young adults' and older adults' risk aversion. -Furthermore, a change in the sensitivity to either gains or losses should be reflected in the emotional reactions to gains and losses.

Decision Making under Risk across the Life Span

Choice under risk allows researchers the detailed analysis of behavior in gain and loss domains as well as of possible asymmetries between the two (Mata & Hertwig, 2011). A wide range of laboratory gambling tasks has been used to investigate decision making under risk. In most of these tasks, participants choose between a sure outcome and the uncertain prospect in the domain of monetary gains or losses (e.g., Mather et al., in press; Mikels & Reed, 2009; Weller, Levin, & Denburg, 2010). Very few studies have investigated decision making under risk in a broad age-range covering adolescence to old adults. In one of the few exceptions, participants from the ages 5 to 85 (but excluding 12-17 year-old adolescents) were tested on a task requiring to choose between a sure option to win points and a risky option with uncertain outcomes (Weller et al., 2010). This study found that risk-taking in the gain domain decreased across the life span whereas it was relatively stable in the loss domain. Risk aversion for gains and risk seeking for losses is frequently interpreted as reflecting loss aversion, in that a certain loss is particularly undesirable and hence encourages risk taking (e.g., Rozin & Royzman, 2001). Therefore, one way to interpret the Weller et al. finding is that loss aversion remains stable across the life span. Other studies have focused either on developmental trajectories from childhood into adulthood or on age-related differences between young and older adults. In the following brief review on age-related differences in experimental decision-making tasks, we focus on the age groups included in the present study, namely adolescents, young adults and older adults.

Adolescents compared to adults. Aversion to risk (defined as the uncertainty of gains or losses associated with a decision) increases from childhood to adulthood (for review see, Boyer, 2006). Laboratory studies of risk preference found that adolescents are less risk-averse than adults (Boyer, 2006; Burnett, Bault, Coricelli, & Blakemore, 2010; Harbaugh,

Krause, & Vesterlund, 2002)[4]. In a decision-making task that used variance in reward relative to the expected value (coefficient of variation, CV) as an index of risk found that adolescents were less risk averse than young adults (Paulsen, Platt, Huettel, & Brannon, 2011). In mixed gambles, i.e., gambles simultaneously involving gains *and* losses, adolescents and young adults were equally loss averse in a way that potential losses had a significantly greater effect on choice than potential gains in both age groups (Barkley-Levenson, Van Leijenhorst, & Galván, 2013). Similarly, adolescents and young adults did not differ in their choices between two gambles that varied in risk level[5] and expected value (Paulsen et al., 2011), further indicating that there are no age-related differences between adolescents and young adults in choices in mixed gambles. In contrast, compared to young adults, the group of male adolescents showed more willingness to make risky choices, defined as a preference for the gamble with greater variance (Burnett et al., 2010). Similarly, in the Columbia Card Task, adolescents behaved more risky compared to adults, with risk taking defined here as turning over more cards when the probability of losing all winnings increased with card flips (Figner, Mackinlay, Wilkening, & Weber, 2009). This age-related difference emerged only when participants received immediate feedback after turning cards (i.e., the "hot version" of the task), but not when they chose the overall number of cards to flip prior to receiving

[4] Harbaugh et al. (2002) investigated a larger age range (5-64 years) but collapsed results of participants between the age of 21 – 64 to one group of adults. In our view, this is problematic as goal orientation changes from young to older adulthood (e.g., Ebener et al., 2006). Another problem with this study is that it used different incentives for the age groups (points to exchange for toys vs. money), making comparisons between the age groups difficult.

[5] Risk level was operationalized as coefficient of variance (Weber, Shafir, & Blais, 2004).

feedback (i.e., the "cold version;" Figner et al., 2009). Feedback, then, may have a different emotional meaning to adolescents than to younger adults.

Taken together, the pattern of findings regarding differences between risk preferences in adolescents compared to young adults is mixed. Particularly experiments with mixed gambles have lead to inconsistent findings. Furthermore, immediate feedback seems to have a differential impact on emotions in adolescents compared to young adults.

Young compared to older adults. Experimental studies on age-related differences in risk attitudes between young and older adults also present a mixed picture. A meta-analysis on age-related differences between young and older adults in experimental risk-taking tasks found little evidence that risk taking in decisions from description (i.e., a task that provides information on potential outcomes and their probability) changes across the life span (Mata et al., 2011). Overall, there were no clear age-related differences depending on the framing of the task in terms of gains or losses. In decisions from experience (i.e., tasks such as the Iowa Gambling Task (IGT) that allow learning the probabilities of gains and losses through experience), differences between young and older adults seemed mainly caused by decreased learning performance in older adults. Mata et al. concluded this from the following pattern of findings: Older adults showed more risk seeking behavior than young adults when learning should have led to risk-avoidant behavior, and the reversed effect when learning should have led to risk-seeking behavior.

In a recent study by Mather and colleagues (in press), age-related differences in risk preferences for monetary outcomes emerged when participants were offered a choice between a risky and a certain gamble. Moreover, compared to younger adults, older adults exhibited more risk aversion when the task was framed in terms of gains, and more risk seeking when the task was framed in terms of losses. This pattern can be interpreted as a

greater loss aversion in older compared to younger adults. However, there were no age-related differences for risky gambles. Other studies have provided evidence for greater loss aversion in older adulthood for both, decisions under certainty and for risky choices involving uncertainty (e.g., Gächter, Johnson, & Herrmann, 2007; Johnson, Gächter, Herrmann, 2006). Overall, then, findings on age-related differences between young and older adults are inconclusive. Note, that most of these studies involve either hypothetical gains and losses or very minor monetary ones without establishing the equivalence in the incentive values of very small amounts of money. As discussed in more detail below, to address this shortcoming of the previous studies, our study included both monetary and non-monetary gambles.

Physiological Reactions to Gains and Losses

Relative asymmetries in the importance of gains and losses for decision making should also occur in emotional reactions to gains and losses. Thus, the current study also included the investigation of age-related differences in emotional reactions to gains and losses. In order to avoid potential biases associated with self-report after making a decision, we assessed emotional reactions on the physiological level. More precisely, emotional reactions were operationalized as differential sensitivities of electrodermal activity (EDA) measured as skin-conductance responses (SCRs), and heart rate (HR) measured as event-related heart-rate change. Physiological reactions to emotional stimuli are well established, with distinct psychophysiological reaction patterns to a range of emotional stimuli (for a review see Bradley, Keil, & Lang, 2012). Following this approach, psychophysiological responses during an experimental task index emotional processing. With respect to decision making, previous research has shown more physiological arousal following negative events in decision making than following positive events as indexed by skin conductance (Bechara,

Damasio, Tranel, & Damasio, 1997; Crone, Somsen, Van Beek, & van der Molen, 2004; Löw, Lang, Smith, & Bradley, 2008), pupil dilation (Hochman & Yechiam, 2011; Satterthwaite et al., 2007), and heart rate (Crone et al., 2004; Hochman & Yechiam, 2011). Even in the absence of behavioral loss-aversion, losses lead to heightened autonomic responses compared to equivalent gains (as indicated by pupil dilation and increased heart-rate; Hochman & Yechiam, 2011). However, in some of these studies, physiological reactions were compared to gains and losses that differed in size and frequency (e.g., in all forms of the Iowa Gambling Task; for a discussion see Hochman & Yechiam, 2011). Very few studies have investigated age-related changes in physiological reactions to gains and losses in decision making. One of the few exceptions has shown no age-group differences in outcome related autonomic activities for children and adolescents (Crone & Van der Molen, 2007), and between young and high functioning older adults in the Iowa Gambling Task (Denburg et al., 2009). To our knowledge, there are no studies to date that investigated differences between adolescents, young and older adults in physiological reactions to gain and loss feedback in decision making.

Type of Incentive

The majority of the presented experimental studies investigated decision making in tasks with monetary gains and losses or points that were later converted to real monetary rewards. However, the incentive value of money may change across the life span. Money may not be equally important to young and older adults. Winning 5 Dollar may have a different meaning to a high school student compared to a college student or a retired older person. Providing some support for this reasoning, when facing a goal-conflict between the maximization of their personal monetary outcome and contributing to protect the environment in a complex problem-solving task, older adults optimized the contributions to

the environment whereas younger adults seemed to focus more on their personal monetary gains (Freund & Blanchard-Fields, 2013). Therefore, when comparing different age groups, one should go beyond monetary tasks that might not motivate adults of different ages to the same degree.

Some studies have investigated decision making in non-hypothetical gambles that involved a series of decisions. In a study by Mather et al. (in press), participants learned only after having made all of the decisions which of their choices would be selected to determine the actual outcome (e.g. Mather et al., in press). Note, that this adds additional uncertainty to the outcome of decision making and might lead to different decisions than ones that involve immediate feedback (see the "hot" vs. "cold" task in the experiment by Figner et al., 2009). Arguably, many choices in real life lead to contingent feedback and, more importantly, most decisions in real life have some consequence (very unlike the above described task where only one of the decisions out of a series will lead to an outcome). To address these issues, we designed a non-hypothetical task that involved actual consequences for each decision.

One of the crucial elements for investigating potential valence effects on decision making is to keep the intensity of gains and losses equal. If the greater impact of a negative or positive stimulus is due to the greater intensity of that stimulus, findings might reflect an intensity effect rather than asymmetrical impact of gains and losses (Peeters & Czapinski, 1990). Thus, we developed a task that uses metric incentives, namely time in seconds that participants can win or lose in order to work on an anagram task. This procedure ensures that gains and losses have a meaning to the decision maker as time is crucial in an anagram task and can be assumed to be equivalent across age groups.

The Current Study

The main goals of the present study was threefold: (1) To investigate age-related differences between adolescents (13-17 years), young adults (18-30 years) and older adults (> 65 years) in risk taking, (2) their emotional reactions to gains and losses, and (3) to extend previous studies by using non-monetary yet metric incentives (time) and compare them to choices between non-monetary gambles. In order to address these objectives, we developed a non-monetary, non-hypothetical gambling paradigm. Non-monetary incentives (i.e., time available for solving the task) were embedded into an anagram task (i.e., building words out of a string of letters). Participants chose between two mixed-gambles represented by two (spinning) wheels of fortune to win or lose time to work on the anagrams. Skin-conductance responses and heart rate were assessed during the experiment to measure emotional reactions to gain and loss feedback. Additionally, participants choose between a series of choices between a sure option and a risky outcome in the gain and loss domain, and choose or reject monetary mixed gambles.

Based on the literature concerning changes in goal orientation across the life span, we hypothesized that adolescents place the largest emphasis on gains in decision making compared to younger and older adults, and an increase in the importance of losses across adulthood. We expected to find a behavioral difference on a descriptive level in terms of an increase in risk aversion from adolescence to old age. Furthermore, we assumed that, across the life span, emotional reactions should be increasingly stronger following losses relative to gains as manifested in more heart-rate deceleration (i.e., heart-rate slowing) and stronger skin-conductance responses (indexing arousal).

Method

Participants

Overall 136 participants took part in the study (40 adolescents, 45 young adults, 51 older adults). Of these, 23 participants were excluded from the analyses because they chose the left option in all 40 trials of the non-monetary gambling task (17 adolescents, 3 young adults, 3 older adults). The final sample consists of n = 23 adolescents (13- 17 years; M = 15.32; 43.5% female), n = 42 young adults (18- 30 years; M = 24.63, 71.4% female) and n = 43 older adults (64- 85 years; M = 72.02, 53.7% female). All participants were native German speakers. All adolescents were high school students, the majority of young adults were university students (70%) and the majority of older adults were retired (95%). More information about participant characteristics including their education is listed in Table 6 (for level of education attained by parents of participants in the adolescent sample see Appendix E). Participants were recruited via the participant pool of our laboratory and by contacting churches and schools.

Procedure

The study consisted of an online-questionnaire that participants filled out from home and a session in the lab. In the online-questionnaire, participants gave socio-demographic information and responded to personality questionnaires, and performance tests on numeracy and vocabulary assessment. They also chose between series of hypothetical monetary lotteries. For the lab session, testing took either part in our laboratory or in a quiet room in a school. Testing was done individually or with two participants. Upon arriving in the laboratory, participants provided written informed consent. They then filled out the digit symbol task of the WAIS (Wechsler, 1955). Subsequently, participants were familiarized with the procedure for recording psychophysiological responses and electrodes were placed

for the assessment. Participants were then instructed to the anagram task described below. They solved four practice anagrams and then worked on the non-monetary gambling task. The entire experimental session lasted approximately one hour. After completing the experiment, participants were debriefed and received a monetary compensation of 30 Swiss Francs (equivalent to approximately 30 USD at this time) for the online and lab session.

Table 6

Participant Characteristics

	Adolescents	Young adults	Older adults		
	n = 23	*n* = 42	*n* = 48		
Measure	%	%	%	χ^2 (14, N= 104)	p
Education				146.15	p < .05
… still in school	100	5			
Obligatory school			2.4		
Apprenticeship		10	43.9		
Upper professional training			17.1		
High school		62.5	9.8		
2 year college			9.8		
University degree		22.5	9.8		
....other			7.3		

Table 6 (continued)

Participant Characteristics

	Adolescents		Young adults		Older adults			
	n = 23		*n* = 42		*n* = 48			
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	F(1, 136)	*p*
Age in years	15.32	1.0	24.63	2.84	72.02	4.77		
Life satisfaction	5.96	.98	5.65	.80	5.95	.84	1.55	.22
Subjective health	5.78	1.09	5.83	.59	5.78	.76	.038	.96
Numeracy	1.61	.99	2.19	.92	1.56	1.13	4.73	.01
Vocabulary	15.96	3.66	21.50	6.84	19.81	13.73	2.28	.11
Digit symbol	51.65	8.79	64.90	11.84	42.71	51.92	43.72	<.001
Personality								
Extraversion	3.20	.36	3.15	.33	3.01	.31	3.097	<.05
Agreeableness	3.15	.54	3.39	.63	3.02	.62	3.77	<.05
Openess	3.58	.79	4.08	.67	4.27	.60	7.78	.001
Neuroticism	2.91	.64	2.97	.70	2.45	.61	7.26	.001
Conscientiousness	3.59	.47	3.64	.41	3.54	.32	.67	.512
Optimism	4.22	1.11	4.18	1.01	4.48	.84	1.01	.37
Sensation seeking	3.33	.67	3.23	.53	2.91	.46	4.45	.01

Assessment of Skin Conductance and Heart Rate and Data Reduction

Skin conductance and heart rate (HR) recordings were performed with a Biopac MP150 system (BIOPAC Systems, Inc., Goleta, California). The signal of psychophysiological data was recorded and event-marked with AcqKnowledge Software

(Version 4.1; Biopac Systems). Data were sampled with 1 kHz, the low-pass filter was set to 0.05 Hz and no high-pass filter was activated. Skin conductance was recorded using disposable Ag/AgCl electrodes filled with isotonic (0.05% NaCl) electrolyte medium. The electrodes were attached to the hypothenar eminences of the palm of the non-dominant hand (so that participants could operate the computer mouse and the keyboard with their dominant hand). The skin-conductance signal was transformed into units of micro Siemens. In order to minimize motion artifacts, the participants were asked to lay their non-dominant hand next to the keyboard and keep it as still as possible. Skin-conductance responses were derived using the event-related EDA analysis script of the AcqKnowledge Software detecting SC-peaks between 1-4 seconds following the feedback of the wins or losses in this particular trial. In order to correct for individual differences in physiological variables influencing the skin conductance, we performed a range-correction of all SCRs (Lykken, Rose, Luther, & Maley, 1966). HR was recorded using disposable Ag–AgCl ECG electrodes filled with isotonic (0.05% NaCl) electrolyte medium. The electrodes were secured to the upper body to measure heart rate. During the experiment, skin conductance and the electrocardiogram (ECG) were continuously recorded. Interbeat intervals were obtained from deviations between the ECG R-waves and were later transformed to beats per minute (bpm) according to a Graham-transformation (Graham, 1978). Feedback-related heart-rate change analysis was prepared by selecting the measurements 3 seconds prior to feedback (while the wheel was spinning until it stopped) and for 8 seconds after the feedback for each trial. Changes from baseline scores were calculated, using 1-second baseline measurements immediately preceding the beginning of the wheel spinning. Heat-rate and skin-conductance data of 19 persons had to be excluded due to problems in acquisition or too many

movement-artifacts. Additionally, the analysis of the skin-conductance data does not include 13 non-responders.

Material and Instruments

Vocabulary. Given that the non-monetary gamble concerned winning or loosing time for an anagram task, we wanted to ensure that the age groups did not differ in vocabulary. To this end, participants had to indicate which one out of five strings of letters was a real word in the spot-a-word task (Lehrl, Merz, Burkhard, & Fischer, 1991). Replicating previous findings (Li et al., 2004), vocabulary remained stable into old age. There were no significant age-related differences in vocabulary (see Table 6).

Numeracy. Given that the gambles involved information about the likelihood of gains and losses, we assessed numeracy skills with a three-item scale (see Appendix; Schwartz, Woloshin, Black, &Welch, 1997). Age groups significantly differed in correctly solving the three items. Post-hoc comparison using the Scheffe test revealed that the young adults (M = 2.19, SD = .92) outperformed both other age groups (see Table 6), $p < .05$, whereas adolescents (M = 1.61, SD = .99) and older adults (M = 1.56, SD = .16) did not differ significantly, $p > .05$.

Personality. We assessed optimism with a 10-item Optimism scale (LOT-R; Herzberg, Glaesmer, & Hoyer, 2006). Cronbach's alpha was .75. The "Big Five" personality factors were assessed using a short version of the NEO for openness, neuroticism, .99 conscientiousness and .99 for agreeableness (BFI-S in German; Rammstedt & John, 2005). Cronbach's alpha was 1 for openness, .99 for neuroticism, .99 for conscientiousness, and .99 for agreeableness. We used a longer version of extraversion with 40 items (NEO-PI-R; Costa & McCrae, 1990; German version by Ostendorf & Angleiter, 2004) because

extraversion has been argued to measure sensitivity to positive rewards (e.g., Depue & Collins, 1999). Cronbach's alpha of extraversion was .79.

Digit symbol. The Digit symbol test (WAIS; Wechsler, 1955), consists of a table displaying a code in which digits and symbols are matched. Additionally, there are double boxes with a digit in the top and a blank bottom box. Paticipants then use the code table to subsequently fill in the blank boxes with the associated symbol. Participants were asked to write as many symbols as possible in the empty boxes below each digits within 90 seconds. The age groups differed significantly in the performance on the digit symbol task (see Table 6).

Subjective health and life satisfaction. We assessed life satisfaction with one item asking participants to rate their overall satisfaction, and subjective health with one item asking participants to rate their overall health. Both items were rated on a 7-point scale from 0 (very bad) to 6 (very good). Reported life satisfaction and subjective health did not differ between age groups (see Table 6).

Monetary Gambles. We assessed risk-aversion in monetary gambles with several series of choices between a sure option and an risky alternative: A series of 21 choices between a sure gain of varying amounts (0 - 100 Swiss Francs in increments of 5 Franks) and a 5% chance to win 100 Swiss Francs; a series of 21 choices between a sure win of varying amounts (0 - 100 in 5-Frank increments) and a 95% chance to win 100 Franks; a series of 21 choices between a sure loss of varying amounts (0 - 100 in 5-Frank increments) and a 5% chance to lose 100 Franks; a series of 21 choices between a sure loss of varying amounts (0 - 100 in 5-Frank increments) and a 95% chance to lose 100 Franks. We assessed loss-aversion with a series of choices between mixed gables with a 50% chance to lose 100 Franks and a 50% chance to win varying amounts (0 - 600 in 20-Frank increments).

Non-monetary gambles. In the non-monetary gambling task, mixed gambles were introduced in the context of an anagram task. The anagram task required creating as many words as possible out of a string of 7 letters. Participants chose between lotteries that offered a chance to win or lose time to work on an anagram. For each anagram, participants were endowed with 40 seconds. Winning time was an additional resource for finding more solutions, whereas losing time made it harder. Each gamble was presented as a pie chart (i.e. lottery wheel, see Figure 5 for an example).

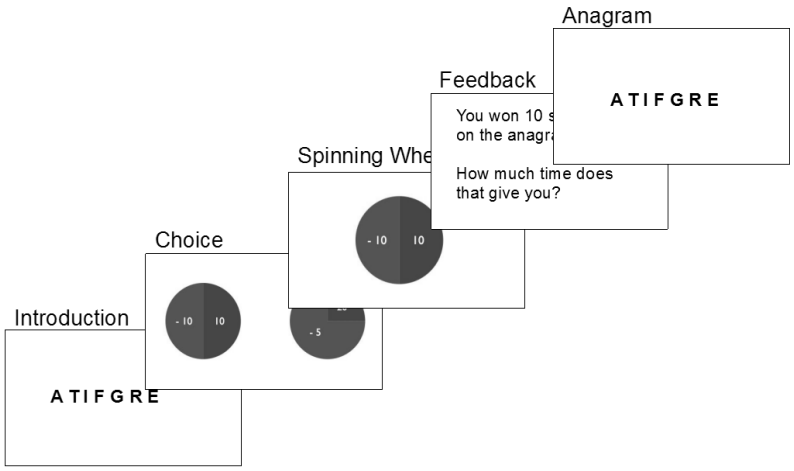

Figure 5. Schematic overview of one trial in the non-monetary gambling task

Gains and losses ranged from 5 to 30 seconds. The probabilities for gains and losses were indicated by the respective area on a pie chart in red for losses and blue for gains. Probabilities ranged from 10 to 90 percent (10%, 25%, 50% 75%, 90%). In each trial, participants were first introduced to the anagram. Then they were asked to choose one out of two gambles that depicted different wins or losses, respectively, but amounted to the same expected utility. Then they saw the chosen lottery wheel spinning with a fixed arrow in the middle that pointed upwards. When the wheel stopped, the arrow indicated whether they had won or lost. Subsequently, feedback on the outcome (amount of seconds won or lost

for solving the respective anagram) appeared on the screen. To make sure that participants payed attention to the outcome of the gamble, they were asked to calculate how much time they had in total to work on the anagram and enter it on the computer screen. Time won to work on the anagram had to be added to the 40-second endowment, time lost to work on the anagram to be subtracted. There was a total of 40 trials, each consisting of one anagram task and one gamble for time. Acceptable solutions to the anagram task required words to consist of at least 4 letters.

Results

Behavioral Responses

Monetary Gambles. The following analyses focused on the monetary and non-monetary choices and how they relate to each other.

Monetary sure option versus risky option. A repeated-measures ANOVA was performed with age as a between-participant and choice set as a within-participant factor. There was a significant main effect for choice set, $F(3,58) = 30.52$, $p < .01$, $\eta_p^2 = .61$. There was no significant main effect for age, $F(2, 60) = .98$, $p = .38$, $\eta_p^2 = .03$, and no significant interaction between choice set and age group, $F(6, 118) = 1.53$, $p = .17$, $\eta_p^2 = .07$, in gain and loss gambles as well as gambles involving low and high probabilities (see Figure 6).

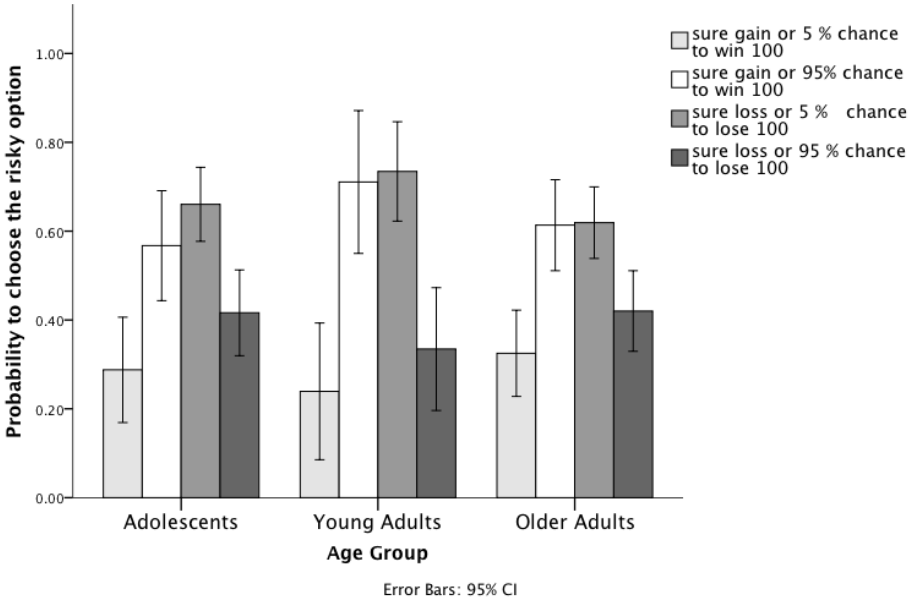

Figure 6. Mean proportions of adolescents, young and older adults selecting the risky (i.e., not-certain) option when choosing between a sure option or prospect with high or low probability in the domain of gains and losses

As can be seen in Figure 7, in gain gambles participants sought risk for low probability prospects (i.e., the point of indifference was *above* the expected value of the gamble). The expected value is marked in the Figure by a vertical line. Participants were risk averse for high probability gambles (i.e., the point of indifference was *below* the expected value of the gamble).

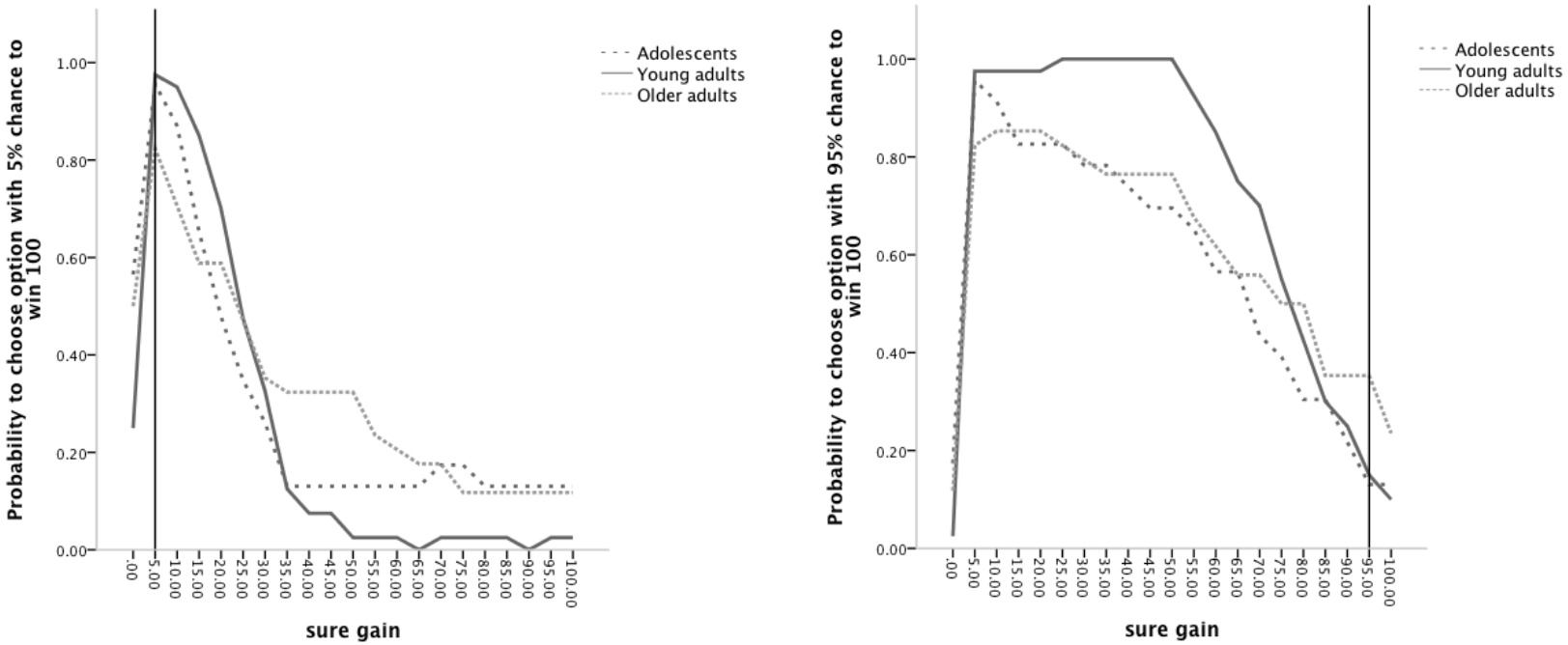

Figure 7. Mean probability to choose the risky option over a sure gain. The risky prospect has either a low probability (upper graph) or high probability (bottom graph). The vertical line indicates the expected value of the risky option

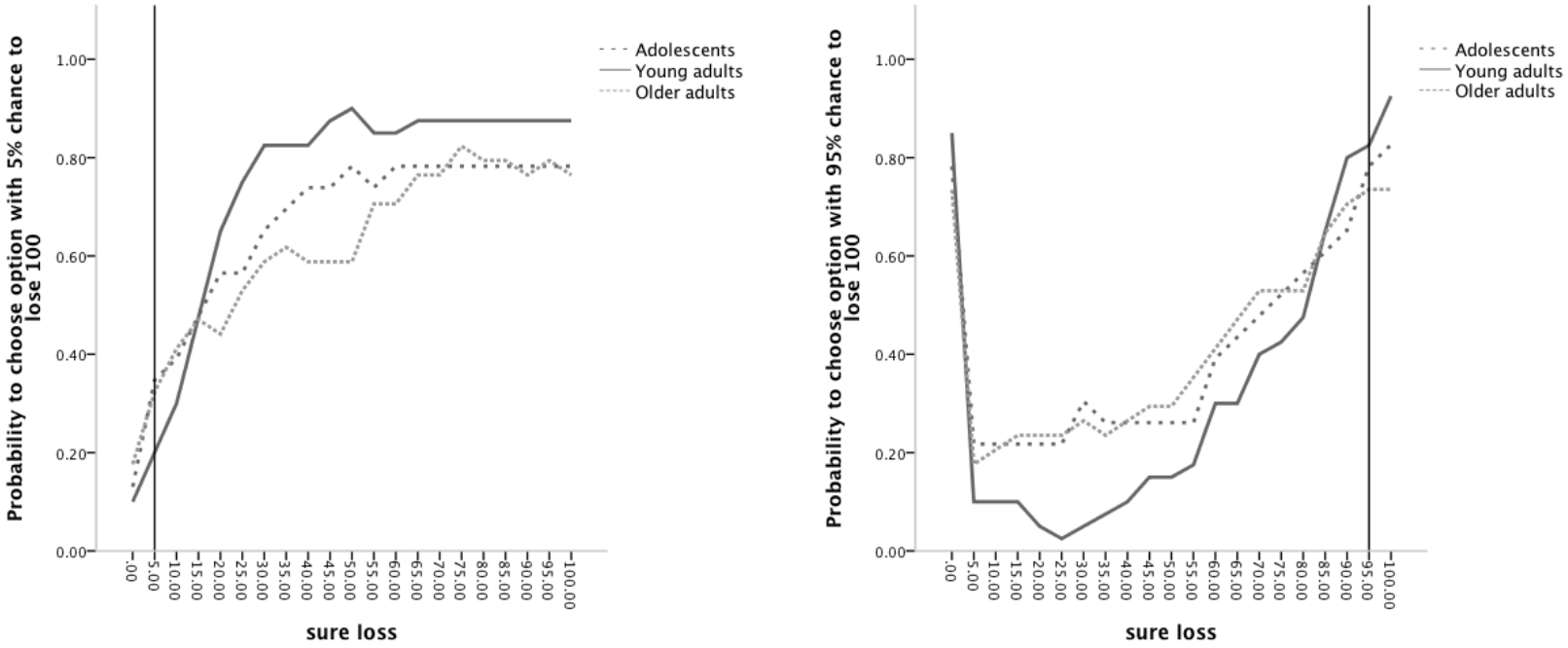

Figure 8. Mean probability to choose risky option over a sure loss. The risky prospect has either a low probability (upper graph) or high probability (bottom graph). The vertical line indicates the expected value of the risky option

As can been seen in Figure 8, in loss gambles participants were risk averse for low probability losses and risk seeking for high probability losses. This set of findings converges with the well-known tenet of Prospect Theory by Kahneman and Tversky (1979) that people are risk seeking when high losses are at stake but risk averse in the case of potential high gains.

Mixed monetary gambles. When participants either chose or rejected monetary mixed gambles, accepting a mixed gamble was riskier than rejecting it in terms of the range of possible outcomes. Adolescents accepted the mixed gamble in 59% of the cases (M = .59, SD = .29), young adults in 62% (M = .62, SD = .28) and older adults in 53% of the cases (M = .53, SD = .37). There was no significant difference between age groups in the average likelihood to accept the gamble $F(2, 96) = .78$, $p = .46$, $\eta_p^2 = .02$. Figure 9 illustrates an increase in the likelihood to accept a gamble with increasing potential gains.

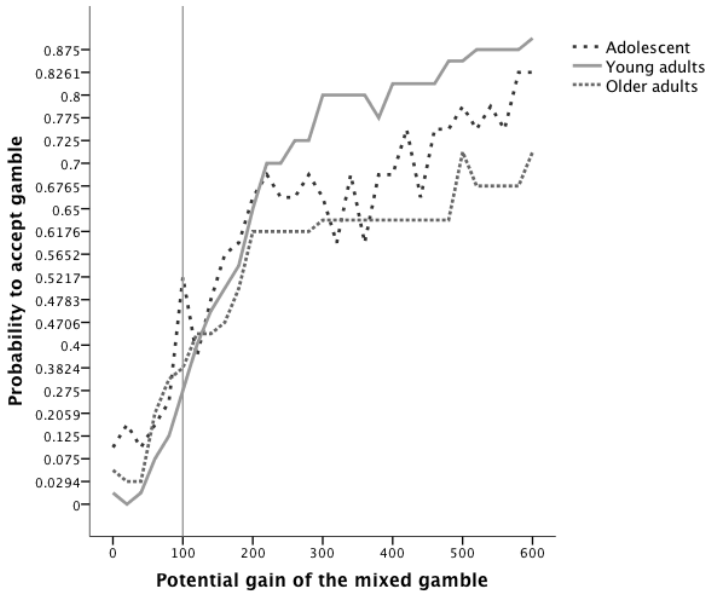

Figure 9. Mean probability to accept a mixed gamble by age group with increasing potential gain. The choice involved choosing or rejecting a series of mixed gambles with a 50 %

chance to lose 100 and a 50 % chance to win an amount (depicted on the x-axis). The vertical line indicates equal size of potential gain and loss in the gamble

Non-monetary gambles. One way to define the risk of an option is by the *range* of the potential outcomes (Fox & Poldrack, 2009).[6] Based on this definition, 57.7% of adolescents chose the riskier option, 55.7% of young adults and 47.1% of the older adults.[7] One sample t-test run separately per age group, showed that these probabilities were significantly different from 50% for adolescents, $t(22) = 2.44$, $p < .05$ and young adults, $t(41) = 3.01$, $p < .05$, but not for older adults $t(40) = -1.12$, $p = .27$. A one-way ANOVA of probability to chose the risky option by age group revealed a significant main effect for age group, $F(2,103) = 5.18$, $p < .01$, $\eta_p^2 = .09$. Post-hoc comparison using the Scheffe test indicated that the mean probability to take the riskier option did not differ for adolescents ($M = 0.57$, $SD = .15$) and young adults ($M = 0.55$, $SD = .12$), $p = .87$, but both groups differed significantly from older adults ($M = 0.47$, $SD = .17$), $p < .05$.

Comparison of risk taking in all choices involving risk. In order to compare the age groups' inclination to take the riskier option across the different measures of risk taking (see Figure 10), we performed a repeated-measures ANOVA with age group as between-participant and decision task as within-participant factor. There was a significant interaction of age group and type of gamble (monetary vs. non-monetary gamble), $F(10,182) = 2.39$, $p <$

[6] We did not use the coefficient of variance (CV; Weber et al., 2004) because the choice options had the same expected value. Furthermore the EV was 0 in some cases, rendering it impossible to calculate the CV.

[7] This analysis is based on 38 of the 40 trials, as two had the same range.

.05, η_p^2 = .12. The main effect for decision type was significant, $F(5,90) = 45.37$, $p < .05$, η_p^2 = .72, the main effect for age group was not, $F(2, 94) = 0.87$, $p = .42$, η_p^2 = .02.

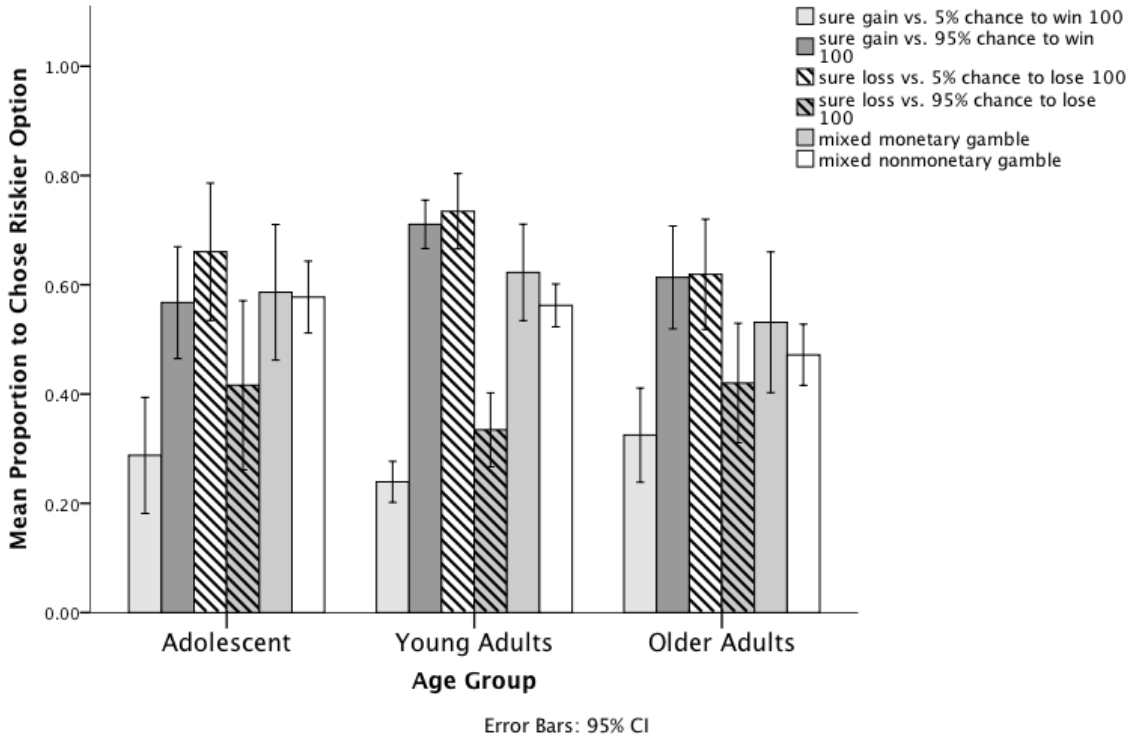

Figure 10. Mean proportions of adolescents, younger and older adults selecting the riskier option (i.e. sure option in choices between sure outcomes vs. risky gamble; accepting the mixed monetary gamble; choosing the nonmonetary gamble with larger variance. Error bars represent 95 % confidence intervals

Anagram task performance. Participants solved on average $M = 1.14$ words (SD = .75) per anagram. The overall performance on the anagram task did not differ by age group, $F(1,102) = 1.41$, $p = .24$. Confirming the assumption that having more time for solving the anagram constitutes a gain, time for the task was positively correlated with task performance, $r(4054) = .16$, $p < .01$. Separate analyses for the three age groups showed

correlations of $r(886) = .16$, $p < .01$ for adolescents, $r(1718) = .17$, $p < .01$ for young adults, and $r(1450) = .16$, $p < .01$ for older adults. A test for the equality of the correlation coefficients by age group, showed that there was no significant difference in the z-transformed correlation coefficients, $\chi^2(2) = 0.15$, $p = .93$. This latter result supports the assumption that winning or losing time to work on an anagram has the same meaning to participants of all age groups.

Heart-Rate Change and SCRs Following Feedback

The following analyses focused on event-related changes in autonomic physiology in response to feedback. That is, how did skin conductance and heart rate change after the spinning wheel stopped and participants found out whether they had won or lost and by how much? First, analyses of skin-conductance responses will be presented, followed by a presentation of the heart-rate changes.

Skin-conductance responses. SCR amplitude captures the phasic increase in conductance shortly following stimulus onset and usually ranges between 0.1–1.0 μS (Dawson, Schell, & Filion, 2007) and reflects the arousal dimension of affect indexing its intensity (e.g., Figner & Murphy, 2011). An analysis of variance revealed a significant difference in range-corrected SCR amplitude between the age groups, $F(2, 957) = 20.55$, $p < .01$, $\eta_p^2 = .04$ (see Figure 11). The main effect for feedback (gain vs. loss) was not significant, $F(1,957) = 1.08$, $p = .29$, $\eta_p^2 = .001$, nor was the interaction of age group and feedback, $F(2, 957) = 1.24$, $p = .29$, $\eta_p^2 = .003$.

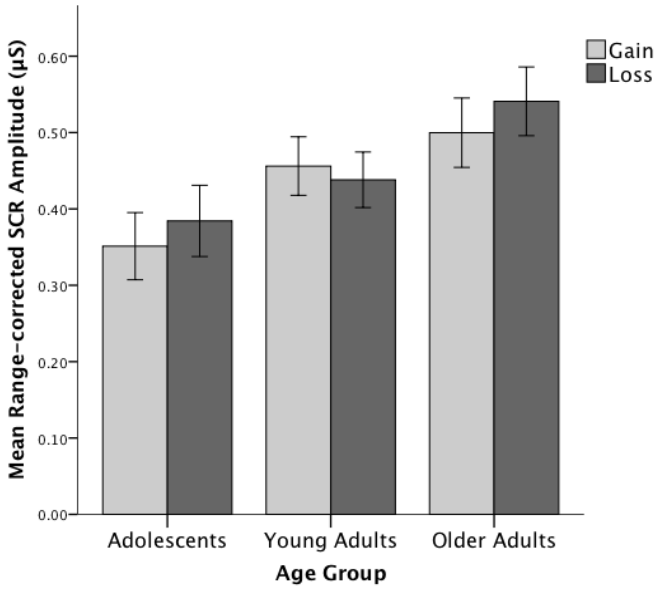

Figure 11. Mean amplitude of Skin Conductance Responses (SCRs) in mircoSiemens (µS) by age group and outcome (gain vs. loss). Error bars represent 95 % confidence intervals

The main effect of age might be due to decreases in physiological reactivity in older adults (Uchino, Birmingham, & Berg, 2010). As the Lykken transformation amplifies small reactions relative to the persons` reactivity, this can lead to the impression that older adults have the strongest reactions because their overall reactivity is smaller than that of the other two age groups (see below for more detailed analyses of heart rate).

Heart-rate change. Figure 12 shows the pattern of heart-rate (HR) change in anticipation of the feedback and the response to gains and losses across time.

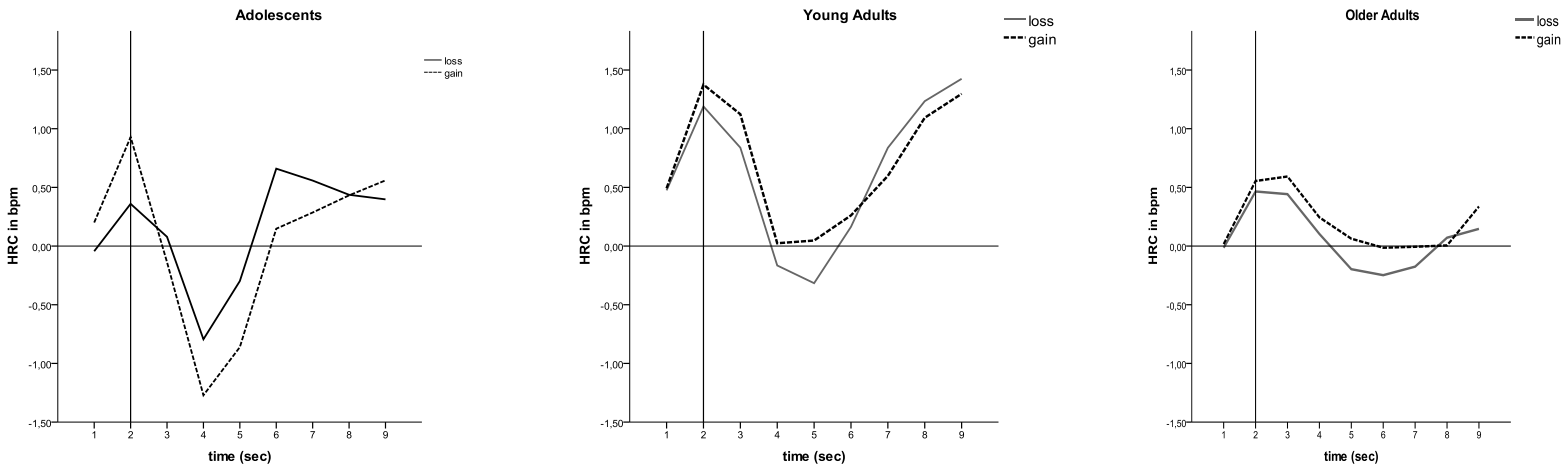

Figure 12. Heart rate change in beats per minute (bpm). Dotted line depict the reaction to gains, solid lines depict the reaction to losses. The vertical line indicates the time of feedback

These graphs depict the typical bi-phasic pattern of an orienting reaction (Graham & Clifton, 1966; Lang, Bradley, Cuthbert, 1997; for reviews see Bradley, 2000; Hodes, Cook, & Lang, 1985). The first phase is indexed by an initial HR deceleration, interpreted as a sign of attentional orienting, mediated by the parasympathetic branch of the autonomic nervous system (e.g., Bradley, 2009; Bradley, Codispoti, Cuthbert, & Lang, 2001; Graham & Clifton, 1966; Osumi & Ohira, 2009), the second phase is indexed by a later HR acceleration, an indicator of emotional arousal and sympathetic activity (Bradley & Lang, 2007; Cook, Hawk, Davis, & Stevenson, 1991).

For further analysis, we calculated the heart-rate deceleration in response to the feedback as the difference between the heart rate at the time of feedback and the minimum heart rate in the four seconds following the feedback. We then performed an ANOVA to investigate differences in heart rate deceleration by age group and feedback (gain vs. loss). There was a significant main effect for age group, $F(2, 3482) = 152.28$, $p < .01$, $\eta_p^2 = .08$, a significant main effect for feedback (gain vs. loss), $F(1, 3482)=5.18$, $p < .05$, $\eta_p^2 = .02$ and a small but significant interaction of age group and feedback, $F(2, 3482)= 5.38$, $p < .05$, $\eta_p^2 = .003$. The large main effect of age group replicates the age-related difference in physiological reactivity reported in the meta-analysis by Uchino et al. (2010).

As can be seen in Figure 12, adolescents showed a larger drop in heart rate in response to gains compared to losses. Young and older adults showed a larger drop in heart rate in response to losses compared to gains. The heart rate drop in response to feedback was not significantly correlated with features of the chosen option (potential gain, potential loss, probability of gain, probability of loss) or the size of the outcome (see Table 7), nor was skin conductance. Although this finding may seem counterintuitive, behavioral and physiological measures are often uncorrelated (e.g., Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005).

Table 7

Pearson Product-Moment Correlations Between Features of the chosen option and Physiological Reaction

Measure	1	2	3	4	5	6	7	8	9	10
1. Outcome		.05**	.08**	-.07**	.07**	-.01	-.01	.03	.01	.01
2. Potential Gain of Chosen Option			-.26**	-.02	.03*	.83**	-.01	.02	.00	.04
3. Potential Loss of Chosen Option				-.59**	.58**	-.76**	-.02	-.01	-.02	-.05
4. Probability to Win					-.99**	.33**	.01	.01	-.01	.01
5. Probability to Lose						-.32**	-.01	-.01	.01	-.01
6. Range of the Chosen Option							.01	.02	.01	.05
7. Anticipatory Rise in HR								.27**	.25**	-.03
8. Second Phase Rise									-.31**	-.07
9. HRC in Reaction to loss										.00
10. Range-corrected SCR										

Note. HRC in Reaction to feedback refers to the deceleration in response to the feedback.

** $p < .01$ (2-tailed); * $p < .05$ (2-tailed).

Discussion

The main goal of the current study was to investigate age-related differences in reactions to risk in a non-monetary gambling task. Supporting our hypothesis, we found that older adults were less likely to choose the riskier option out of two mixed gambles. At the same time, there were neither age-related differences in the willingness to accept risk in choices between a sure outcome and a risky option in gambles in involving monetary gains or losses. This finding is in accordance with previous studies that did not find age-related differences between adolescents and young adults in this type of task (Harbaugh et al., 2002) and the conclusion of a recent meta-analysis that there are no clear age-related differences between young and older adults (Mata et al., 2011).

Replicating the fourfold pattern of risk attitudes in Prospect Theory (Tversky & Fox, 1995; Tversky & Kahneman, 1992), we found that participants of all age groups were risk seeking in low probability prospects over gains, risk averse in high probability prospects over gains, risk averse in low probability prospects over losses and risk seeking in high probability prospects over losses. Furthermore, the willingness to accept a mixed monetary gamble did not differ between age groups, replicating previous comparison of adolescents and young adults (e.g., Paulsen et al., 2011) and studies comparing young and older adults (e.g. Mather et al., in press). Importantly, these tasks required hypothetical choices between options concerning monetary gains and losses. In order to compare such decisions with a non-hypothetical and non-monetary task, the current study also included a newly developed the "Letter Lottery Gambling"-Task.

In contrast to the hypothetical, monetary gambles, the Letter Lottery Gambling Task revealed age-related differences in choosing the riskier out of two options. Older adults were significantly less risk seeking compared to adolescents and young adults. We interpret this pattern of findings as support for our reasoning that age-related differences in risk attitudes may be best operationalized with non-monetary incentives. In the Letter Lottery Gambling task, the incentive represents a resource for solving the task (i.e., time for finding words in an anagram). In this way, the incentive is inherent to the task rather than external to it. The positive correlation between time available for the task and performance suggests that winning or losing time represents a gain or loss to participants of all age groups. Note, that the task was designed to draw on resources that do not decline with age (i.e., vocabulary; Li et al., 2004), and all age groups did, in fact, perform equally well on the anagrams as well as on the vocabulary test. The Letter Lottery Gambling task, then, seems appropriate for investigating age-related differences in decision making and in reactions to gains and losses.

Because the attitude towards risks in choice is often assumed to be driven by loss aversion, arising from the anticipation that losses have a greater impact on affect than gains, we investigated emotional process measures both, while *anticipating* (HR) and after *receiving* gain or loss feedback (HR, SCR). With increasing salience of losses in older age (Freund & Ebner, 2005), older adults were expected to show stronger emotional reactions to losses than to gains. In contrast, adolescents were expected to react most strongly to gains. These expectations were confirmed: With increasing age, reactions to losses were stronger (young and older adults showing larger heart rate deceleration in response to losses than to gains), whereas adolescents showed a stronger reaction (heart rate deceleration) to gains than to losses. These results are in line with a previous study that showed that younger adults had stronger autonomic reactions - as indexed by pupil dilation and heart rate change - to losses than to gains (Hochman & Yechiam, 2011).

The current study also included skin-conductance responses as a measure of arousal. Range-corrected SCR differed in amplitude for age groups with older adults showing the strongest reactions relative to their overall reactivity. This finding could be interpreted as the subjective importance older participants place on the task in general. More important in the current context and counter to expectations, there were no differences between gain and loss feedback in arousal and no interaction of age and feedback. However, given that skin-conductance responses mark the *intensity* of arousal rather than valence (e.g., Figner & Murphy, 2011), this finding might indicate that gains and losses in the anagram task are equally arousing to participants of all age groups.

Limitations and alternative explanations. Although the hypotheses were derived from a motivational life-span developmental account of the changing importance of gains and losses (Depping & Freund, 2011; Freund & Ebner, 2005), the experiment did not

directly test the impact of motivation on decision making. Instead, we indirectly assessed the importance of gains and losses through the behavioral and physiological reactions to decisions involving gains and losses. The results are in partial agreement with the hypothesis, providing some support for the reasoning. However, alternative explanations are also possible: For instance, a cognitive control account construes risky decision making in adolescents as a result of immature cognitive control capacities with a simultaneously thriving reward sensitivity (Somerville, Jones & Casey, 2010). In aging research, developmental decline in cognitive control has been discussed as a potential factor contributing to age-related differences in risk taking (e.g., Bruin, Parker, & Fischhoff, 2012). Assuming that risk taking changes as a function of the inverted U-shaped trajectories in cognitive control, reflected in maturation in adolescence and decline in old adulthood, one would expect an inverted U-shaped pattern of risk taking. However, the results of our study are more supportive of assuming a linear increase across age groups in risk aversion in non-monetary gambles. Note, however, that the current study did not include middle-aged adults, constraining claims of a linear developmental trajectory from adolescence into old age.

Taken together, the present study introduces a new task that allows the investigation of age-related differences in non-hypothetical, non-monetary decisions. This approach may help to stimulate more research on age-related differences outside the realm of monetary gambles that either involve very small gains and losses (in non-hypothetical games) or are purely hypothetical, and thus may carry little meaning for the participants. By embedding the incentives into the task (i.e., gaining or losing resources that are of immediate relevance for performance on the task at hand), gains and losses might be more meaningful and seem to elicit different reactions than hypothetical, monetary gambles. Going back to the

overarching question of this research: Who is afraid of losses? We asked whether a shift in goal orientation from a primary orientation towards gains in adolescence and young adulthood to a stronger orientation towards the prevention of loss in older adulthood impacts decision making. The results of the current study suggest that the importance of preventing of losses is also manifested in avoiding risks in older adults. Stressing the emotional aspect of the question "Who is *afraid* of losses?" older adults and young adults had a stronger heart rate slowing in reaction to losses compared to gains. Although there were no behavioral differences between adolescents and young adults, adolescents showed a stronger heart-rate slowing in response to gains than to losses. This latter finding supports the hypothesized gain-orientation in adolescents. Taken together, then, motivational life-span development seems a promising theoretical perspective for the study of behavioral and emotional differences in decision making in a broad age rage.

GENERAL DISCUSSION

The starting points of the present research were the linking of motivational life-span developmental considerations with decision-making research and the identification of mechanisms in decision making that are likely to vary as functions of goal orientation. A common theme of all three chapters presented above is that changes in motivation across life span may affect decision making. Chapter I gave a theoretical introduction to the theme and its major hypothesis, the motivational prevention-of-loss hypothesis. This hypothesis postulates that older adults focus more on potential losses in decision making because they are more motivated to prevent losses. The subsequent chapters presented empirical studies to test the age-related prevention-of-loss hypothesis. The studies presented in Chapter II and III investigated this hypothesis with different methodological approaches and by stressing differential implications of the overarching hypothesis, which are reflected in the guiding questions introduced in the introduction. Chapter II addressed potential age-related differences in information processing, employing an incidental memory paradigm. Chapter III addressed potential age-related differences in risk-preferences for monetary and non-monetary gambles as well as emotional reactions to gains and losses. Another major theme to this research is the focus on age-related differences between young and older adults. Chapter III extended the perspective to a broader age range, including adolescence. The following sections first summarize the previous three chapters with respect to the guiding questions set forth in the introduction[8], then relate the studies to each other and discuss each with respect to the overarching hypothesis established in Chapter I. Finally, open questions, limitations, and future directions are discussed.

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8 Please see the discussion sections of Chapters II and III for a detailed summary and discussion of all results, including interesting peripheral findings.

Chapter I

From a Motivational Perspective, Why Should there be Age-related Differences in Decision Making?

Chapter I introduced the theoretical background of this dissertation, bridging three assumptions from the fields of judgement and decision-making research and motivational life-span developmental research: (a) gains and losses can have asymmetrical impacts in decision making, (b) personal goals influence decision making, and (c) personal goals are subject to developmental change. Integration of these three assumptions yields a primary argument: Motivational development associated with normal aging affects decision making. More specifically, a motivational prevention-of-loss hypothesis is derived. This hypothesis claims that older adults' decision making is more strongly affected by potential loss compared to that of young adults because prevention of loss becomes increasingly important in later adulthood. Goal orientation changes from a predominant orientation towards gains during young adulthood to an increasingly strong orientation towards the prevention of loss during later adulthood (Ebner et al., 2006; Freund, 2006), reflecting the increasing losses in resources (Baltes, 1997). Assuming that goals can serve as reference points for the evaluation of decision outcomes (Heath et al., 1999), a change in goal orientation across adulthood may also affect decision making (Depping & Freund, 2011). Furthermore, although decision-making literature has recognized that choices are influenced by goals, there is very little research addressing the impact of goal orientation on decision making, and even less with regard to aging in particular. Review of previous research on age-related changes in the processing of gains and losses provided a picture of mixed results. Chapter I outlined potential directions for future research that could address these theoretical questions.

How Could Age-related Differences in the Relative Emphasis of Gains and Losses in Decision Making Manifest?

In Chapter I, it was argued that goal orientation could influence preferences and decision strategies (e.g., information processing). Moreover, instead of just focusing more on emotional information per se (Finucane, 2008), older adults could rely more on loss-related information. The goal to prevent a loss could lead to stronger focus (e.g., of attention) on losses, less focus on gains, or both. Additionally, based on previous research, we proposed that studies on age-related differences in decision making should consider their employment of incentives (monetary vs. non-monetary), investigate domain differences, and observe dynamics across the decision-making process. First, we proposed that age-related differences may best be studied using non-monetary but metric incentives. Non-monetary incentives need to have the same meaning to the different age groups (which money may not, see also Chapter III) to make sure there is no difference in the intensities of the stimuli. Along the same lines, metric incentives can be manipulated easily and objective intensity can be controlled for. Second, we argued that there may be systematic differences between decision domains, given that developmental expectations concerning gains and (resource) losses in these domains differ (e.g., Baltes & Smith, 2003). Rather than presenting a domain-general decision-making style in order adults, sensitivity to losses may depend on an interaction between the situation (e.g., availability of resources) and the decision maker (e.g., individual goal orientation). For example, in the domain of health, older adults may be particularly sensitive to losses because developmental decline is normative and expected, therefore the adoption of prevention-of-loss goals is likely. Third, we argued that there could be a shift in relative sensitivity to gains and losses across different phases of the decision-making process. For example, in the pre-decisional phase a focus on negative choice features allows prevention of negative outcomes. However, in the post-decisional phase a focus on negative outcomes seems only adaptive

for learning from experience. With respect to potential affect-regulation goals in older adults (e.g., (Kim et al., 2008), it could be most adaptive to focus on positive aspects to promote choice satisfaction. Additionally, Chapter I provided a discussion of potential applications of knowledge about decision-making processes in older adults such as better communication efforts about issues like advance care planning, medical treatment, and housing options.

Table 8. Answers to the Guiding Questions in Chapter I

Guiding questions in Chapter I	Summary of answers and references to chapters in which the theme is explored
From a motivational perspective, why should there be age-related differences in decision making?	The shift in goal orientation that mirrors developmental gains and losses could lead to relative preference for gain-related and loss-related information in decision formation
How could age-related differences in the relative emphasis of gains and losses in decision making manifest?	Age-related differences could manifest in strategies → Chapter II Age-related differences could manifest in preferences → Chapter III Additional concerns: Age-related differences could occur depending on the decision domain → Chapter II Age-related differences could occur depending on the type of incentive → Chapter III Age-related differences could occur depending on the phase in the decision-making process → Chapter III

A previous review of age-related changes in decision making suggested that the "negativity bias" observed in young adults' decision making (i.e., loss aversion) could change in older adulthood in three ways, which the authors named (1) affective bias, (2) positivity bias, and (3) lack-of-negativity bias (Peters, Diefenbach, Hess, & Vjästfall, 2008). According to previous work, an affective bias would lead to an enhancement of the negativity bias because affective information is generally more salient. In contrast, a positivity bias would result when older adults weigh positive information – but not negative information – more heavily. The latter type of bias would occur when negative information was suppressed, weakening the negativity bias in older adults (Peters et al., 2008). The current review argued for an additional alternative for the development of loss aversion in old age, namely a shift to a focus on the negative in order to avoid potential negative consequences. Although the definition of "affect bias" specifies the same implication for loss aversion, affect bias would not always make the same prediction; it would suggest an increased reliance on positive information when both negative and positive occur simultaneously. Following the names Peters and colleagues (2008) chose for the potential developmental trajectories of loss aversion, this effect could be called "negativity bias". However, rather than naming the effect according to its expected valence asymmetry, we named the associated hypothesis in accordance with its function: "motivational prevention-of-loss hypothesis".

Chapter II

Does Information Processing in Decision Making Differ Between Young and Older Adults?

Chapter II dealt with age-related differences in decision-related information processing. As goal orientation shifts across adulthood from a primary orientation towards gains to an increased importance of the prevention of losses, older adults' information processing may be particularly sensitive to potential losses when there is a possibility to avoid them. In line with these motivational changes, we expected older adults to remember more loss-related information when having to

choose one of two options. Using an incidental memory paradigm, young and older adults recalled information on hypothetical choice options that contained positive (gain-related), negative (loss-related), and neutral information.

Is the (Potential) Age-related Difference in Information Processing Specific to Decision Making?

To facilitate comparison of information processing in the context of decision making to information processing for a different purpose, the paradigm contained two conditions. Participants were randomly assigned to one of two conditions (between-participant design). One condition required participants to read two texts and to later choose between the two options presented in those texts (choice condition). The other condition was a control condition that required participants to read the two texts in order to later rate how well they were written (no-choice, control condition).

Does Information Processing Vary as a Function of Content Domain (Leisure vs. Health)?

Chapter II presented two experiments in which the relationships between domain and information processing were investigated. The studies utilized the incidental memory paradigm and presented participants with information on travel packages (decision domain leisure; Experiment 1) or on two hospitals (decision domain health, Experiment 2), requiring participants to make a choice within those domains, or required participants to rate the readability of the texts (control conditions).

The results of the two experiments provide answers to the aforementioned questions. Experiment 1 showed that older adults remembered more negative information than younger adults (and than positive information) when they had to choose one of the travel packages but not in the control condition (evaluating the readability of the texts). Experiment 2 followed the same procedure using a choice between two hospitals for a minor surgery. This choice was assumed to

trigger a stronger orientation towards the prevention of losses compared to the choice between travel packages. As expected, in this choice situation both age groups remembered more negative information relative to neutral and positive information regardless of the condition (choice vs. control). More importantly, results of Experiment 2 again supported the hypothesis that older adults focus more on negative information in a choice condition compared to the control condition. Taken together, results suggest that information processing related to decision making is associated with a stronger focus on negative information in older adults. This effect seems specific to decision making and was present on both experiments, albeit stronger in the health domain, in which losses are more salient.

Table 9. Answers to the Guiding Questions in Chapter II

Guiding questions in Chapter II	Answer
Does information processing in decision making differ between young and older adults?	Yes
Is the (potential) age-related difference in information processing specific to decision making?	Yes
Does information processing vary as a function of content domain (leisure vs. health)?	Yes, partly

Chapter II investigated information processing, following up on topics addressed in other motivational life-span developmental research (Mather & Carstensen, 2005). Goals that individuals pursue create frameworks for interpreting and responding to events and thereby influence patterns of cognition, affect, and behavior (Dweck & Leggett, 1988). In order to approach desired outcomes and avoid undesired outcomes, persons employ strategies (defined as a pattern of decisions) in the acquisition, retention, and utilization of information to meet the objectives (Bruner, Goodnow, & Austin, 1956). The experiments presented in Chapter II were conducted to investigate effects in decision-making strategies suggested in Chapter I. Rather than distinguishing between either

deliberative or affective processing like in dual-processing models (Peters, et al., 2007), motivated cognition accounts (Kunda, 1990; Mather & Carstensen, 2005) assume that information processing is influenced by the person's goals and motives. In Chapter II, we investigated whether information processing for decision-making tasks in older adults differed from that in young adults and compared to information processing for other tasks. We assumed that in the decision condition, what the person remembered about the choice options would reflect what mattered most to him or her during decision formation. It has been previously established that memory is designed to provide information that is relevant in a given context and that a person is most likely to need (Anderson & Milson, 1989). Moreover, goals affect the encoding, storage, and retrieval of information, and guides attention (e.g., Wyer & Srull, 1986). More specifically, we assumed that older adults would remember more negative information, reflecting a prevention of loss strategy. Our findings support this hypothesis. Furthermore, the findings also show that information processing differed as a function of task. These findings are particularly important because assumptions about age-related changes in decision making are often based primarily on research on the better-studied age-related changes in general information processing (e.g., Peters et al., 2007; Mather, 2006). However, the results of our experiments in Chapter II suggest that information processing in decision making differs systematically from information processing for other purposes.

The presented experiments were the first study, to my knowledge, to test and show a systematic difference in information processing in decision making compared to other types of information processing in older adults. Theories on age-related differences in decision making need to incorporate the distinct pattern in information processing and further investigate boundary conditions for different positive-negative-asymmetries.

Chapter III

Do Adolescents, Young and Older Adults Differ in Their Choices for Risky Options?

Chapter III extended previous research in several ways. First, the study extended the age-comparative perspective to adolescents. The presented study investigated decision making under risk in adolescents, young adults and older adults. Second, it employed a new non-monetary mixed gamble task that allowed for investigating decision making with incentives that had the same meaning to all age groups. Equivalent value of incentives was ensured by anchoring the meaning of the decision outcome in a given task: Participants gambled for time to work on an anagram task. Increase in task performance with more time to work on the anagram task was the same for all age groups. Third, the study included measures of emotional reactions to gains and losses. Emotional reactions were indexed by the psychophysiological measures of heart rate change and skin conductance responses.

Is there an Age-related Difference in the Willingness to Accept Risk Depending on the Incentive (Money vs. Time)?

In order to compare risky decision making in the new non-monetary, non-hypothetical task to monetary gambles, we included a series of choices between hypothetical monetary gambles. Results suggested that older adults' decision making was more risk averse compared to adolescents and young adults in non-monetary choices. However, we did not find age-related differences in monetary choices. These results support the notion that non-monetary choices could reveal a differential pattern of behavior when gains and losses have the same meaning to all age groups as opposed to when they do not, which is arguably the case for monetary incentives. However, the current data do not allow for distinguishing between "real" asymmetries and "non-real" asymmetries. Moreover, we cannot disentangle the effect of the type of incentive and whether the gamble was hypothetical or not. Nevertheless, there seem to be systematic differences between

types of incentive. Supporting our prevention-of-loss hypothesis, older adults were less willing to take risks compared to young adults.

Are there Age-related Differences in the Emotional Reactions to Gains and Losses?

Physiological reactions replicated a general decline in physiological reactivity (Uchino et al., 2010), here measured with skin conductance responses and event-related heart rate change. However, within age groups we found a pattern that converged with our hypothesis. All age groups had an equally strong skin conductance response in reaction to gains and losses, indexing arousal (e.g., Figner & Murphy, 2011). Feedback was arousing, independent of outcome. Event-related heart rate change showed a bi-phasic orienting response. Adolescents had the strongest heart rate slowing in response to gains, indexing orienting (e.g., Bradley et al., 2012), whereas young and older adults' heart rate slowed more strongly in response to feedback that indicated loss.

Table 10. Answers to the guiding questions in Chapter III

Guiding questions in Chapter III	Answer
Do adolescents, young and older adults differ in their choices for risky options?	Yes, partly
Is there an age-related differences in the willingness to accept risk depending on the incentive (money vs. time)?	Yes
Are there age-related differences in the emotional reactions to gains and losses?	Yes

Chapter III presented tests of the prevention-of-loss hypothesis in older adults in a classic decision-making framework and extended the framework by using physiological process tracing techniques. Furthermore, the studies presented in Chapter III also extended the framework from prevention-of-loss hypothesis in late adulthood to a promotion-of-gain hypothesis in adolescents. Avoiding risks is another way in which older adults could avoid potential negative outcomes indirectly by minimizing uncertainty about the outcome. Following the prospect theory framework

(Tversky & Kahneman, 1992) introduced in Chapter I, there are more ways in which prevention-of-loss strategies in decision making could be investigated. Namely, loss aversion in a prospect theory model could be modeled (Mata & Hertwig, 2011) and framing effects that reflect loss aversion could be investigated. Both approaches will be discussed in greater detail in the section addressing future directions, below.

The experiments presented in Chapters II and III confirm that older adults' decision making seems to reflect prevention of loss in information processing (Chapter II) and risk aversion for non-monetary gambles (Chapter III), as well as stronger orienting for losses compared to gains (Chapter III). The asymmetry in the processing of positive and negative information and the emotional consequence of gains and losses seem to contradict other accounts of (socio-)emotional life-span development (Carstensen et al., 1999), which predicts a positivity effect in older adults. However, below I will make a case that the two types of preference for negative or positive are (a) adaptive in specific contexts and (b) very likely to co-exist.

Functions of Asymmetrical Processing of Positive and Negative Information

The co-occurrence of positive and negative biases has been integrated in the concept of positive-negative asymmetry in a framework of social-cognitive theories (Peeters, 1971; Peeters & Czapinski, 1990; Lewicka, Czapinski, & Peeters, 1992). The concept promotes dealing with negativity and positivity effects as part of a more comprehensive and behavioral adaptive mechanism.

> "On the one side there is a positivity bias reflecting an approach bias which is functional to achieve at least some of the scarce positive life outcomes possible in a world with much larger potential for negative outcomes. The risk involved in this bias is compensated for by a subjective overemphasis of the negative or negativity effect which is functional to avoid accurately the negative outcomes" (Peeters & Czapinski, 1990, p. 38).

This statement conveys several assumptions. In this description, asymmetrical processing of positive and negative information in which both valences of information co-exist but one is favored is adaptive with respect to specific purposes. It implies that different styles of information processing depend on the person's goals (e.g., achieving positive outcomes and accurately avoiding negative outcomes) in a given context. Positivity and negativity effects are considered adaptive when they facilitate goal pursuit. Moreover, according to the behavioral-adaptive theory of positive-negative asymmetry, evaluative meanings of attributes reflect the attributes' incentive values for approach and avoidance (Peeters & Czapinski, 1990). Additionally, switching between the different goals and respective information processing styles depending on ecology (i.e.. the world and its risks) is considered adaptive, as goals to achieve good and avoid negative are conceptualized to complement each other.

In the next section, I first briefly introduce the adaptive functions each kind of asymmetries may have in general, then with respect to developmental changes and decision making in particular. Next, I discuss the studies presented in this dissertation in the light of these theoretical accounts. The concept of positive-negative asymmetry provides a guiding principle to integrate valence effects in life-span development. Finally, I describe a framework for how the different life-span theories of development and their predictions about approach and avoidance of loss goals may interrelate, based on hierarchical goal models.

Functions of Negativity Effects

Information processing that favors negative information over positive is assumed to reflect a general negativity bias, the tendency for humans to pay more attention to negative than positive information in a wide range of domains including perception and decision making (e.g., Baumeister et al., 2001; Brosch & Sharma, 2005; Rozin & Royzman, 2001; Cacioppo & Berntson, 1994; Öhman, Lundqvist, & Esteves, 2001; Öhman, Flykt, & Esteves, 2001; Pratto & John, 1991; Taylor, 1991,

Kahneman & Tversky, 1979). As argued before, a negativity effect can therefore be interpreted as a function of the goal to evade negative consequences. Negativity biases may reflect a functional mechanism, because detecting a threat increases the odds of survival (e.g., Öhman, Lundqvist, & Esteves, 2001). Concerning life-span development, both young and older adults detect angry faces faster than sad or happy faces, which can be interpreted as intact threat detection in old age (Mather & Knight, 2006). With respect to decision making, a "vigilant" or conservative decision-making strategy aims to avoid losses and can reduce costly errors and help to evade threats (e.g., Crowe & Higgins, 1997). The motivational prevention-of-loss hypothesis suggests that focusing on negative aspects helps older adults to exert prevention of loss goals, in order to cope with resource loss associated with aging (Depping & Freund, 2011).

Functions of Positivity Effects

A positivity bias in terms of preference for positive representations ("hypotheses") about reality has been argued to help guide individuals' behavior towards positive outcomes rather than achieving accuracy (Peeters, 1971). Therefore, the positivity bias was interpreted as an approach bias that can help with interacting in familiar environments as well as exploring new environments[9]. In the light of socio-emotional life-span development, compared with young adults, older adults have been argued to be generally more emotionally positive reflecting the "positivity effect" (e.g., Carstensen et al., 1999; Labouvie-Vief & Blanchard-Fields, 1982). This positivity effect has been defined as the relative preference for positive over negative stimuli, serving emotion-regulative goals in older adults (e.g., Reed & Carstensen, 2012). The positivity effect in older adults compared to young adults was suggested to be caused by the motivation to maximize wellbeing in the face of a limited time perspective (socio-emotional selectivity theory, e.g., Carstensen et al., 2003). Similar to

[9] This concept is similar to the notion of "positivity bias"as "unconditional optimism"(Czapinksi, 1985a).

the claim of increased emotion regulation, older adults have been argued to better integrate affect and cognition than young adults do (Labouvie-Vief & Blanchard-Fields, 1982), leading to better regulation of emotion by older adults (Gross et al., 1997; Labouvie-Vief, Hakim-Larson, DeVoe, & Schoeberleim, 1989). An alternative account has posited that positive preferences result from worsened cognitive and physical functioning in older adults as a way to simplify information processing (the simplified processing account; Consedine, Magai, & Bonanno, 2002; Labouvie-Vief, Diehl, Jain, & Zhang, 2007). Because older adults' optimization of affect was found to co-occur with low levels of affective complexity, researchers concluded that older adults prefer positive over negative stimuli in order to compensate for declining complexity (Labouvie-Vief et al., 2007). Similarly, it was argued that positive affective orientation in older adults compensates for declining somatic systems and resources (Consedine et al., 2002). However, recent research indicating that cognitive control processes are required to produce a positivity bias speaks against the theory of compensation for cognitive decline (Isaacowitz, Allard, Murphy, & Schlangel, 2009; Knight et al., 2007; Mather & Knight, 2005). With respect to decision making, it may be particularly adaptive to be more satisfied with one's choice and show less regret after choices to maintain overall wellbeing (Depping & Freund, 2011). Adolescents' stronger approach tendency (Cauffman et al., 2010) could be argued to be adaptive with respect to learning independence (e.g., Spear, 2000).

Taken together, research indicates that both kinds of asymmetries, negativity effects and positivity effects, can serve specific functions and are in that sense adaptive or beneficial. But when does each asymmetry occur?

Integration and Shift between Positivity and Negativity Effects

As discussed in Chapter II, the life-span developmental prevention-of-loss hypothesis contradicts predictions of the prominent socio-emotional selectivity theory. But are they really contradictory? One way to resolve the seeming contradiction between the prevention-of-loss

hypothesis and positivity effects in many other contexts is through their common motivational theme, personal goals.

People have a multitude of different personal goals that do not simultaneously guide behavior and that can be represented in a hierarchical manner (Carver & Scheier, 1998). Promoting one's wellbeing may be a higher-order goal, though when a threatening event occurs, the more proximal goal of avoiding the threat is more likely to guide behavior in that moment. The goal of evading threat in that moment may dominate information processing during goal pursuit and serve the higher-order goal at the same time. Figuratively speaking, when we meet a beautiful, snarling dog, it is more likely that we will focus on the dog's bared teeth, which warn of the dog's potentially injuring us and prompt us to be cautious, than on its beautiful features, which may be inviting us to pat the dog. This reaction seems adaptive at all stages of the life span. The goal of preventing negative consequences does not conflict with a higher order goal directed at wellbeing. Conversely, the prevention of immediate, negative consequences may be instrumental to the higher order goal, although goal attainment strategies may not overlap (Riediger & Freund, 2004). In fact, paying attention to the negative in the present can help avoid negative outcomes in the future and thus foster positive affect in the future. Similarly, Peeters and Czapinski (1990) previously argued that a general positivity bias (i.e., approach tendency) has to coincide with a strong sensitivity to aversive stimuli in order to avoid the detrimental effects of constant approach behavior. When we manage to escape from a threatening situation, we may feel very relieved. In contrast, using the same example, when we meet a friendly dog, it is most adaptive not to focus on frightening features of the dog so as to not be unnecessarily scared. Therefore, it can be maladaptive to focus on negative aspects of the present at all times. Instead, flexible shifts between different processing strategies may be most beneficial.

Early drive theory perspective assumed that people choose a course of action or one object over another because it satisfies one or more of many basic physiological and psychological needs, e.g., hunger, thirst, love (Maslow, 1954; Murray, 1938). According to Maslow (1954), needs exist in a hierarchical organization, such that lower-level "deficit" needs (physiological and safety needs) must be satisfied before higher-level "growth" needs (belongingness, esteem, and self-actualization needs). A theory that posits maximization of positive affect as a primary goal in a specific group – like socio-emotional selectivity theory does for older adults – cannot ignore that detecting stimuli that lead to negative consequences when it is possible to avoid the negative outcome serves the purpose of increasing positive affect. With respect to life-span developmental changes in threat-detection, older adults – just like young adults – have been reported to detect discrepant threatening stimuli faster than other stimuli in a series of pictures of faces (Mather & Knight, 2006). Concluding, there may be particular situations in which negative stimuli are particularly important for older adults to evade negative consequences in contrast to a general positivity effect.

There are other features of goals that may play a role in the occurrence of specific valence-asymmetries. Goals can be described in terms of a variety of dimensions (e.g., Locke & Latham, 1990; Austin & Vancouver, 1996). Goals can be more or less specific, vary with respect to their time perspective, and can be approach- or avoidance-oriented. Socioemotional selectivity theory distinguished between goals geared towards information vs. affect. However, with respect to goals it is unlikely that these are orthogonal constructs. On the contrary, information-seeking goals could be more or less affective. Similarly, approach vs. avoidance orientation may not be the only descriptive dimension that defines a specific goal. This issue will be discussed in greater detail in the future directions.

To summarize the previous section and the results of Chapter II, the goal for which a person strives in a given situation may influence how the person processes information in that situation. As

a consequence, information processing is likely to be situation-specific and depend on the currently activated goals. The different information processing strategies that favor either positive or negative aspects of a given situation can be adaptive in different contexts. Along these lines, some authors have argued that efficient goal pursuit requires that information processing is flexibly adjusted to a current goal by changing the focus of attention correspondingly (e.g., Rothermund, Voss, & Wentura, 2008; Goschke, 2000; Norman & Shallice, 1986). Which goal will be activated in a given situation may depend on different situational factors (e.g., control) and person-specific factors (e.g., age-related developmental expectations). The situational context may trigger which goal is selected. For example, an avoidance goal may be adopted in the face of potential resource loss (Hobfoll, 1989, 1998; Freund & Riediger, 2001). A given situation may be defined in terms of the possible action ecology the person has. Which alternatives are available can depend on available resources that vary with age. The ability to control for what is going to happen may be a key to heightened attention towards signals of threat. Imagine, for example, that you can choose between two hiking routes to a destination you would like to go to, e.g., a picnic site. One route requires crossing a narrow bridge over a canyon but provides a picturesque view, and the other does not cross the canyon, takes 20 minutes longer, and does not provide as nice of a view. If you are a little afraid of heights, taking the longer route might seem like the better strategy. Now imagine that you have to get to the picnic spot and there is only one route: it requires you to cross a canyon on a narrow bridge but provides a beautiful view. Given that you are a little afraid of heights, the best strategy seems to cross the bridge focusing on the horizon and the beautiful view it gives you. Depending on the control one has over the occurrence of positive and negative consequences, differential strategies in attention and information processing may be employed. Turning back to experimental settings, in decision making, information processing informs actions that can influence positive or negative outcomes. This may be systematically different from settings in which individuals passively

view information and have to cope with givens. In light of the results presented in Chapter II, we had argued that decision making (as opposed to a control condition) allows one to exert control over outcomes, and thereby prompting older adults' differential information processing strategies directed at the prevention of negative outcomes. The results of Chapter III conversely showed that within decision making, different incentives may also have different meaning with respect to decision-making strategies (i.e., risk aversion), thereby providing indirect support for the notion that asymmetries in processing may depend on context. Furthermore, decision making seems a particularly important field of study for biased information-processing in aging, as it is an activity relevant to everyday functioning. Different contexts may influence whether goals pertain to coping with givens or actively influencing potential outcomes. The research presented in Chapters II and III shows that flexibly shifting between information processing strategies may be particularly important for older adults, and this information therefore has implications for future research on decision making in older populations. Future research is needed to further explore the relationships between adopted goals and situational cues. Some life-span developmental theories may help in guiding further predictions for future studies.

Development and Goal Selection in Context

Flexibility and change in personal goals lies at the heart of motivational life-span developmental theories, as presented in Chapter I. Paul and Margret Baltes (1990) conceptualized successful aging as a lifelong process of maximizing gains and minimizing losses drawing on three fundamental processes: selection, optimization, and compensation (SOC). The theory stresses the importance of prioritizing goals (selection) with respect to their potential to increase gains (optimization) and avoid losses (compensation) with consideration of the currently available resources (SOC, Baltes, 1987; P.B. Baltes & Baltes, 1990; Freund & Baltes, 2002). The metamodel has been applied to adaptive development in adolescence (Gestsdottir & Lerner, 2007; Lerner,

Freund, De Stefanis, & Habermas, 2001) and across adulthood into old age (e.g., Freund & Baltes, 1998; 2000, 2002; Wiese, Freund, & Baltes, 2000). Furthermore, the action theoretical instantiation of SOC allowed for the conceptualization of goal selection and pursuit from a life-span perspective (Freund & Baltes, 2002). Concerning variability in goal orientation, on the one hand, there is developmental change. The line of research on goal orientation upon which this dissertation builds characterizes goal orientation as a dynamic construct that develops across the life span (Ebner et al., 2006, Freund & Ebner, 2005, Freund, 2006, Brandtstädter, 1998). It is assumed that changes in developmental opportunities and constraints influence goal orientation and that the interplay of internal and external resources determines which kind of goal will be adopted (Ebner et al., 2006, Freund & Ebner, 2005). Closely associated with the developmental change across the lifespan are assumptions about flexibility between contexts. Life-span developmental psychology postulates that there are both developmental gains and losses throughout the life span (e.g., Baltes, 1997; Baltes et al., 2006; Heckhausen et al., 1989, Labouvie-Vief, 1980). Further, although the ratio of gains and losses becomes more and more unfavorable in older adulthood, there are developmental gains well into old age depending on the domain. As we argued in Chapter I and II, in some life domains such as health, developmental losses are ubiquitous, whereas other domains present a different picture, reflecting the principles of multidirectionality and multidimensionality (Baltes, 1987; Baltes & Smith, 2003). Adults adopt goals directed at either gain or prevention of loss depending on the life domain, mirroring developmental gains and losses in resources and following SOC principles of adaptive development. Additionally, developmental tasks at specific stages in life could influence the relative importance of life domains and influence which goals are adopted (Havighurst, 1972; Nurmi, 1992; Nurmi, Pulliaien, & Salmela-Aro, 1992). Similar to SOC-theory, other motivational life-span theories have proposed mechanisms to deal with shifts in the ratio of developmental gains and losses, namely, the Dual-Process Model of Assimilation and Accomodative Mode of Coping

(Brandtstädter, 1986; Brandstädter & Renner, 1990), the Model of Optimization in Primary and Secondary Control (Heckhausen & Schulz, 1995; and extension, Heckhausen, Wrosch & Schulz 2010). All of these theories posit that individuals choose goals in accordance with developmental regulation, reflecting adaptive mechanisms in response to developmental losses. For example, older adults engage in compensatory activities to prevent losses in domains that are relevant to self-esteem and identity (Brandtstädter & Greve, 1994) and give up unattainable goals more easily than younger adults (e.g., Brandstädter & Renner, 1990; Heckhausen, 1997). Taken together, the availability of resources in a given domain and expectancy of resource gain or loss may be a key to understanding when people switch between specific goals.

Limitations, Open Questions, and Future Directions

Link between goal and strategy. One of the central limitations in the presented studies is that they do not directly test the hypothesized mechanisms behind asymmetrical memory for positive or negative choice features or the willingness to take risks. More specifically, the hypotheses are based on the assumption that motivational changes drive respective changes in decision-related information processing and decision making, and the presented studies do not directly test these assumptions. The incidental memory experiments presented in Chapter II do investigate the effect of the goal of a specific task (decision vs. readability rating) and infer differential focus on either positive or negative aspects based on post-decisional memory of positive and negative features. The results of the experiments are consistent with the predictions about prevention of loss-related preference for negative features in memory. However, the experiments did not test whether the motivation to achieve or to avoid a specific outcome was associated with a particular information processing style. In the context of the incidental memory studies as well as vignette studies that present different scenarios involving gains and losses and hypothetical coin tosses, Wetried to induce goal orientation in young adults as an attempt to directly link goal orientation and

information processing style. However, the endeavor failed, as our paradigm did not induce goal orientation in younger adults. We tried to induce goal orientation by asking participants to generate strategies to either approach a desired state (e.g., passing an exam well, making new friends) or avoiding an undesired state (e.g., not failing an exam, not losing friends). Previous research has closely linked asymmetries in information processing with underlying motivation (discussed in greater detail below), therefore it is likely that the better memory for negative information in older adults in decision making emerges due to the motivation to avoid negative outcomes. Future research could attempt to confirm the link between goal orientation in a given situation and the behavioral implications on decision making. One approach to do so would be to ask participants about their goals in a naturalistic setting in which participants make real decisions (e.g., comparing information search and incidental memory in persons purchasing a television, a vacation, a car, insurance).

Aspiration level. One could also discuss the effect of goal orientation on information processing in decision making with respect to aspiration. One way in which an avoidance of loss goal could influence the decision maker is by lowering her level of aspiration (cf. Carver & Scheier, 1998; Elliot, 2008). As we discussed in Chapter II, previous accounts of how goals could influence decision making have postulated that the goals could serve as reference points (Heath et al., 1999). Not wanting to lose could be associated with a reference point that accepts any outcome that is not below a specific aspiration level, which would be the status quo when avoiding loss is the goal. This could lead to dramatically different evaluations of outcomes compared to an aspiration level (i.e., reference point) that is well above the status quo. With a higher aspiration level as reference point, more potential outcomes could be considered as losses, even when better than the status quo. The findings on information processing presented in Chapter II suggest, however, that prevention-of-loss goals (given the pattern emerges because of the goal to avoid a negative outcome), might cause

changes in information processing. It is not clear how an aspiration level could impact information processing. Does the focus on negative information reflect a focus on information diagnostic to meet the aspiration? Future research could try to disentangle effects of aspiration level and goal orientation in terms of approach and avoidance.

Cross-sectional design. Another limitation of the studies lies in drawing on cross-sectional designs to approach a developmental hypothesis. On the one hand, the design does not allow disentangling cohort effects from age-related effects. One of the tenets of life-span psychology is the acknowledgement that – as formalized in Bronfenbrenner's bio-ecological model – development is shaped by its historical-cultural context (e.g., Baltes, 1997). On the other hand, there are statistical concerns about extreme group designs (Lindenberger, Oertzen, Ghisletta, & Hertzog, 2011). Ideally, age-related changes should be investigated in a longitudinal design to investigate developmental trajectories.

Future Directions

As briefly mentioned in the discussion of Chapter III, other ways to investigate the age-related differences in loss aversion could employ classic framing paradigms or model loss aversion in the prospect theory framework. A previous study we conducted on age differences in framing revealed no age-related differences. This framing study, described below, provides a context for considering a hypothesis for age-related differences in loss aversion in a prospect theory framework. Additionally, I will present further future directions for research on age-related differences in decision making.

Online study on framing: Evaluation of programs for protection of health and life. We conducted an online study to investigate whether loss aversion in framing tasks is even larger in older adults. Framing effects occur when objectively identical situations generate different decisions depending on whether the situations' presentation emphasises potential losses or gains (Tversky &

Kahneman, 1981). Principles of "rationality" would predict that the way in which identical choices are described ("framed") should not affect choice (Dawes, 1998). However, this assumption has been frequently violated. Most framing studies use hypothetical vignettes in which participants choose between sure options and risky gambles. Studies of framing effects indicate that individuals are risk-averse for decisions framed as gains but risk-seeking for decisions framed as losses (Tversky & Kahneman, 1981). Importantly, loss aversion serves as an explanation of risk aversion when facing a sure gain and risk seeking when facing a sure loss. The few studies that have examined aging and the framing effect to date have produced mixed-results. Rönnlund, Karlsson, Laggnäs, Larsson, and Lindström (2005) employed a decision-vignette paradigm for three different domains (health, arts, and finance) and found no effects of age on choice behavior. In another study, older and younger adults showed no difference in framing in 16 decisions from the domains of health and finance with three frames (gain, loss, and combination; Mayhorn, Fisk, & Whittle, 2002). In contrast, Kim, Goldstein, Hasher, and Zacks (2005) employed similar vignettes and found greater framing effects for older relative to younger adults for health-related decision. This result seems supportive of the main hypothesis of this dissertation, as health is a domain likely to be subject to prevention of loss and maintenance goals in older adults. A common characteristic of all of these studies is that they employed hypothetical vignettes that may lack personal significance. In order to trigger personal significance, Mikels and Reed (2009) developed a monetary incentive task in which young and older adults chose between sure options and risky gambles. The authors showed that positively framed options appear to have equal impact on older and younger individuals, but negatively framed options lead to risk seeking, interpreted as loss aversion, in younger but not older adults (Mikels & Reed, 2009). Again, I would argue that, although the decisions are personal and non-hypothetical, the monetary incentives may not be equally important to both age groups. Additionally, the gambles entail different probabilities for both gains and losses within one option,

which might be difficult to understand (for a discussion of this, see Gigerenzer, 1997; Cosmides & Tooby, 1996). For the Asian disease problem, the classic framing task by Kahneman and Tversky that was the exemplar for the vignettes in all studies reviewed above[10], the framing effect can be largely attributed to participants who are cognitively less able (Stanovich & West, 1998).

Studies that employ choice options that are easy to understand are needed so that cognitive deficits can be ruled out as the cause of the observed effect. This was one of the aims of the current framing study. Following the main hypothesis of this dissertation, the study aimed to investigate whether the tendency towards loss aversion in framing tasks is even larger in older adults. In order to address this question, young and older adults evaluated programs for the protection of health and life – topics that are likely to be equally important to both young and older adults. Each program was presented as either a gain or loss version (between-subjects design; see Table 11 for an example). To simplify the vignettes to ensure that all participants would understand the scenario, gains and losses were separated. When presented with a loss-frame scenario, all potential outcomes were presented as losses and depicted objectively the same outcome as the gain version of the scenario. Participants rated how much they supported the kind of program (endorsement-rating) described. We expected that young and older adults would tend to endorse the program in a gain-

[10] In the Asian disease problem, participants are faced with a scenario in which the outbreak of a disease threatens to kill 600 people. In the gain framing, participants then choose between a sure gain of 200 people saved and an option with 1/3 probability that 600 people will be saved and 2/3 probability that nobody will be saved. In the loss framing, participants choose between a sure loss of 400 people dying and an option with 1/3 probability that nobody will die and 2/3 probability that 600 people will die. Both frames are statistically equivalent and require a choice between a sure outcome and an uncertain gamble.

framing scenario (higher endorsement rating) and to oppose the program in a loss-framing (higher negative endorsement rating) scenario. Additionally, we expected that the opposition in the loss framing would be stronger in older adults. We compared young adults (N = 104; 18-30; M = 25.11) and older adults (N = 71; 60-90; M = 66.55) in evaluating vignettes that were either framed as gains or as losses in a between subjects design. In an online survey, participants rated three short vignettes on a specific way to cope with a threat (Program I: Pandemic, Program II: Hostage-taking, Program III: Forest fire). All participants rated how much they would endorse this approach on a seven-point scale ranging from -3 ("strongly opposed") to +3 ("strongly endorse"). In a between-subjects design, participants rated one of the two versions of each program's description (either gain or loss framing). Each of the four programs' outcomes had been described in terms of potential loss and potential gain with varying percentages (gain:loss, 50:50, 50:50, 70:30).

Table 11. *Example Vignette of the Program in Case of Pandemia.*

A pandemic is imminent. The virus is specifically dangerous to risk groups and lethal in most cases. Among these risk groups are pregnant women. In order to protect these women and their children from an infection, a national immunization plan is about to be launched. But an immunization against the dangerous virus is controversial...
Gain Framing:
It is expected that an immunization will have its desired protective effect for mother and child in 50% of all cases.
Loss Framing:
It is expected that an immunization will lead to an infection of the mother and child in 50% of all cases.

Results. A univariate ANOVA was run for all three programs. There is a significant main effect for framing in all three programs; pandemic, $F(1,175) = 52.6$, $p < .05$, partial eta squared = 0.23; hostage-taking, $F(1,175) = 6.64$, $p < .05$, partial eta squared = 0.04; and forest fire, $F(1,175) =$

26.89, $p < .05$, partial eta squared = 0.14. Hence, young and older adults show a framing effect by endorsing the program in a gain-framing scenario more strongly than in a loss-framing scenario. However, in all three programs there is no significant interaction of framing with age; pandemic, $F(1,175) = 0.56$, n.s.; hostage-taking, $F(1,175) = 0.01$, n.s.; forest fire, $F(1,175) = 2.19$, n.s., showing no difference in the endorsement between the age groups. That is, both young and older adults show a framing effect for gain- and loss-descriptions of objectively identical scenarios, and older adults do not seem be more strongly loss-averse than younger adults.

These results to converge with the findings presented on within-subject effects of framing in hypothetical monetary gambles (Chapter III): young and older do not differ in susceptibility to framing independently of the domain.

Outlook: Prospect theory model of loss aversion. As argued in Chapter I, the shift in goal orientation from growth to maintenance and prevention of loss may translate into the emergence and relative increase of loss aversion from adolescents across adulthood. More precisely, older adults could show increased marginal sensitivity to losses and/or increased loss aversion (Mata & Hertwig, 2011). The prospect theory model would allow determination of whether older adults are more sensitive to losses, less sensitive to gains, both, or exhibit a pattern that would not be predicted by the prevention-of-loss hypothesis. However, researchers have argued that decision making may be best suited to use of heuristics as opposed to "as-if" models that model behaviour based on all available information, like the prospect theory (e.g., Gigerenzer & Gaissmaier, 2011). A heuristic can be defined as a "judgment and decision making mechanism or cognitive shortcut that relies on little information and modest cognitive resources" (Wilke & Mata, 2012, p. 1). In older adults, the prevention-of-loss hypothesis may be modelled as the "maximin" strategy (Savage, 1951), which assumes that the decision maker chooses the option that compares and maximizes the smallest possible outcome (e.g., smallest loss in mixed gambles). For example, in a choice that does

not involve negative outcomes, a person would prefer a coin flip that determined whether she or he wins either 10 or 20 Franks over a coin flip that involves a chance to win 5 or 30 Franks. In gambles that involve both gains and losses, for example, when choosing between a gamble that involves a potential loss of 5 Franks and one that involves a loss of 10 Franks, a person employing the maximin strategy would choose the option in which she or he could potentially lose 5. Conversely, adolescents and young adults may be more inclined to employ a maximax strategy, i.e., to maximize potential for experiencing the maximum outcome. In the previous example, they might prefer a coin flip that determined whether they win either 5 or 30 Franks over a coin flip that involves a chance to win 10 or 20 Franks. Thefore, both prospect theory as well of heuristic models may help to test the motivational prevention-of-loss hypothesis in decision making of older adults.

Outlook: Information search. As discussed in Chapter II, another important question is what information older adults seek in the pre-decisional phase. Since the conclusion of the research presented in Chapter II, I have begun to investigate information search patterns in young and older adults in order to begin resolving some of the contradictions emerging from studies employing different methods (i.e., incidental memory vs. information search). Using a process-tracing approach (Willemsen & Johnson, 2011), participants sequentially seek information on choice options, and that information is labeled as positive, negative, or neutral. This approach aims at investigating whether the focus on negative (loss-related) information emerges during active, pre-decisional information searches in the same way that focus on negative information emerged in recall of choice features. As discussed in Chapter II, previous studies using this kind of procedure (e.g., Löckenhoff & Carstensen, 2007) have found older adults to focus more on positive information during information searches, a pattern that seems to conflict with the incidental memory results presented in Chapter II. My currently ongoing studies aim at better understanding

the contradictory findings by using stimulus material identical to that in the incidental memory experiments so that results can be closely compared.

Outlook: Beyond valence. When considering specific goals (and their characteristics), a new question emerging is to what degree specific information about a choice option is goal conducive or diagnostic of goal conduciveness. The underlying assumption of all of the presented research was that valence reflects goal conduciveness with respect to approach and avoidance goals. More specifically, I assumed that positive information or potential gains were diagnostic for the pursuit of approach goals and negative information or potential losses were diagnostic to pursuit of avoidance goals. However, valence and goal conduciveness, although often similar, are not the same (e.g., Aue & Scherer, 2008). In other words, there may be aspects of information that go beyond mere valence effects, and one dimension that could be worth investigating is goal conduciveness. To illustrate this reasoning, Stephens and Johnson (2000) conducted a comparison of young and older adults' information searches when making decisions about purchasing cold and allergy medications available without prescription, finding that older adults focused more frequently on side effects and drug interactions than did young adults. In a "mere valence effect" account for this finding, the side effects can be considered as negative information that older adults might focus on with the goal of preventing negative outcomes in the future. Similarly, focusing on a medication's potential interaction effects is likely beneficial to prevent negative side effects of interactions with other medications the individuals might be taking. Hence, the information is conducive to the goal of preventing negative consequences. However, the information itself is not negative. Therefore, whether the information itself is positive or negative (valence) may not always reflect diagnosticity with respect to the goal of growth or prevention of loss. In other words, the instrumentality of choosing an option or course of action towards achieving a goal may be signaled by the goal conduciveness that a piece of information reveals. Future research on the effect of personal goals

on information processing in decision making should therefore investigate the effect of goal conduciveness.

Conclusion

Overall, the presented theoretical framework for studying age-related differences from a motivational perspective has put forth the motivational prevention-of-loss hypothesis (Chapter I). The first empirical studies investigating the prevention-of-loss hypothesis in information processing (Chapter II) and risk attitudes and emotional reactions to gains and losses (Chapter III) provide the first support for the new hypothesis. Motivational life-span developmental changes introduce an important perspective to decision making across the life span. Relative sensitivity to gains and losses may depend on an interaction between the situation and the decision maker. Sensitivity to gains and losses may vary depending on the decision domain, subjective control, current resources, and expected resource gain or loss. In light of life-span developmental theory, the identified strategic inclinations for the prevention of loss provide a process-account for one application of SOC strategies.

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ZUSAMMENFASSUNG

Die vorliegende Dissertation setzt in Verbindung, wie sich auf der einen Seite persönlichen Ziele während der Lebensspanne entwickeln und wie auf der anderen Seite Entscheidungen getroffen werden. Dafür wurden drei Annahmen zu einem theoretischen Rahmen verknüpft: a) Gewinne und Verluste (d.h. positive und negative Konsequenzen einer Entscheidung) können unterschiedlich starken Einfluss auf Entscheidungen haben, b) persönliche Ziele beeinflussen Entscheidungen, c) persönliche Ziele verändern sich über die Lebensspanne und reflektieren dabei Gewinne und Verluste von Ressourcen in der Entwicklung. Auf die Integration dieser Annahmen aufbauend, wurde eine motivationale Verlustvermeidungs-Hypothese in der Entscheidungsfindung älterer Erwachsener eingeführt (Kapitel I). Zudem wurden bisherige Forschungsergebnisse in Bezug auf die Hypothese besprochen, die bisher heterogene Ergebnisse zeigten. Wie sich eine motivational bedingte Veränderung der Bewertung von Gewinnen und Verluste in Entscheidungen auswirken könnte, wurden in Kapitel I besprochen und in Kapitel II und III empirisch überprüft. Die Dissertation verfolgte einen multi-Methoden Ansatz um die motivationale Verlustvermeidungs-Hypothese zu prüfen. Differentielle Sensitivität gegenüber Gewinnen und Verlusten wurde operationalisiert als

(1) asymmetrische Informationsverarbeitung von Gewinn-bezogenen (positiven) und Verlust-bezogenen (negativen) Informationen für Entscheidungsfindung, im Vergleich zu der Informationsverarbeitung für einen anderen Zweck (Kapitel II);

(2) Risikoaversion (Risiko ist hier definiert als Unsicherheit über die Konsequenz einer Entscheidung gemessen als Varianz; Kapitel III);

(3) Differentielle Sensitivität in emotionalen Reaktionen auf Gewinne und Verluste (d.h. physiologische Reaktionen in Hautleitfähigkeit und Herzratenveränderung; Kapitel III).

Zusätzlich wurde der Altersvergleich von jungen und älteren Erwachsenen auf Jugendliche ausgeweitet (Kapitel III).

In Kapitel II wurde ein inzidentelles Gedächtnisparadigma angewandt, in dem junge Erwachsene (18-31 Jahre, Experiment 1: n=73; Experiment 2, n = 60) und ältere Erwachsene (60-88 Jahre, Experiment 1, n = 73; Experiment 2, n = 60) Informationen über zwei hypothetische Reiseangebote (Experiment 1) oder zwei Krankenhäuser (Experiment 2) zu erinnern hatten. Die Angebote enthielten positive (Gewinn-bezogene), negative (Verlust-bezogene) und neutrale Information. Um zu überprüfen, ob sich die Informationsverarbeitung abhängig vom Zweck unterscheidet, wurden zwei Versuchsbedingungen untersucht: Teilnehmer entschieden entweder zwischen mehreren Optionen (Entscheidungsbedingung) oder beurteilten die Lesbarkeit (Kontrollbedingung). Die Ergebnisse zeigten, dass ältere Erwachsene mehr negative Informationen erinnerten, wenn eine Entscheidung gefordert war als in der Kontrollbedingung und im Vergleich zu jüngeren Erwachsenen. Dies scheint die motivationale Verlustvermeidungs-Hypothese zu stützen.

In Kapitel III wurden Risikoentscheidungen von Jugendlichen (13-17 Jahre, n = 23), jungen Erwachsene (18-30 Jahre) und älteren Erwachsene (64-85 Jahre, n = 43) in nicht-hypothetischen, nicht-monetären Glücksspielen verglichen. Dabei haben ältere Erwachsene Risiko eher vermieden als junge Erwachsene und Jugendliche. Zusätzlich war die emotionale Reaktion Erwachsener nach Verlusten stärker als nach Gewinnen (operationalisiert als Verlangsamung der Herzrate). Dem gegenüber hatten Jugendliche die stärkste Reaktion nach Gewinnen. Dieses beobachtete Verhaltensmuster unterstützt die Annahme, dass Verluste mit zunehmenden Alter in Entscheidungen wichtiger werden. Die motivationale Verlustvermeidungs-Hypothese wird dadurch gestützt. Abschließend wurde in einer allgemeinen Diskussion unter anderem die Funktion von asymmetrischer Verarbeitung von Gewinn-bezogener (positiver) und Verlust-bezogener (negativer) Information diskutiert und neue Richtungen für zukünftige Forschung dargestellt.

APPENDIX

Appendix A: Experiment 1: Verbatim Instructions for the two conditions.

Imagine that you are planning a trip to the island of Halukita and are reading up on different vacation packages.

In the following, you will read a sampling of reviews written by other vacationers. You will read information about two different vacation packages. Both cost the same.

Please read the reviews carefully. …

Control condition:

… You will then be asked to evaluate how well you think the reviews are written.

Decision condition:

… You will then be asked to select one of the two packages.

Appendix B: Experiment 1: Information on travel packages used in the Incidental Memory Paradigm.

Option Hotel Casa Anna

Positive information:

A. The staff's friendliness can hardly be surpassed, including the staff in the bar, the restaurant, and the room service.

B. The water is magnificent, turquoise-colored, and warm.

C. They served a very delicious and hearty breakfast.

Negative information:

A. The bathroom was really disgusting.

B. You should only book this hotel if you are willing to make concessions while on vacation with respect to the room furnishings and cleanliness.

C. The rooms have paper-thin walls; we could often hear the people in the room next door.

Neutral information:

A. Halukita is the largest island in the Halmutu archipelago.

B. The hotel is run by a friendly Swiss lady.

C. The employees do not speak German.

Appendix B: Experiment 1: Information on travel packages used in the Incidental Memory Paradigm. (continued)

Option Hotel Micador

Positive information:

A. You stay in an idyllic, small, privately owned hotel.

B. I liked the cleanliness and friendliness in the hotel.

C. The hotel is located on a beautiful, wide sandy beach.

Negative information:

A. There is a mosquito net for the bed, but ours had lots of holes in it and the mosquitos found every single hole.

B. In our opinion, the hotel is overpriced.

C. I was not too fond of the annoying diesel engines on the hotel grounds.

Neutral information:

A. Halukita used to be a British colony.

B. You stay in a standard double room decorated in Moorish style.

C. There is no room service as there are no phones in the rooms.

Appendix C: Experiment 2: Verbatim Instructions for the two conditions.

Imagine that you need to have routine surgery and are reading up on different hospitals.

In the following, you will read a sampling of reviews written by other patients. You will read information about two different hospitals. Your health insurance would cover all of the bills from either hospital.

Please read the reviews carefully. …

Control condition:

… You will then be asked to evaluate how well you think the reviews are written.

Decision condition:

… You will then be asked to select one of the two hospitals.

Appendix D: Experiment 2: Information on hospital options used in the Incidental Memory Paradigm.

Option Benedictus Hospital

Positive Information:

A. Admission to the hospital was absolutely trouble-free.

B. Everybody worked together and always gave me the feeling that I was in good hands.

C. The nurses had a good eye for even the patients' smaller worries.

Negative Information:

A. The entire hospital was untidy and dirty.

B. The information provided was not helpful and did not answer my questions.

C. The consultation with the doctor at the end was very short and unfortunately totally incomprehensible.

Neutral Information:

A. The waiting room was located next to the information desk.

B. It has a cozy lounge.

C. The walls in the entrance area were painted light blue.

Appendix D: Experiment 2: Information on hospital options used in the Incidental Memory Paradigm. (continued)

Option Andreas Hospital

Positive Information:

A. Although I didn't have an appointment, I didn't need to wait very long.

B. All of the doctors were nice and understanding.

C. All bathrooms were newly renovated and very modern.

Negative Information

A. The nursing staff was perpetually unfriendly.

B. The eating utensils distributed with meals were often dirty.

C. I found a moldy cookie under the radiator.

Neutral Information

A. Some of the nursing staff was responsible for distributing the food.

B. The waiting room had grey tiles.

The weekly doctor's rounds were short, but sufficient.

Appendix E: Level of Education Attained by Parents of Participants in the Adolescent Sample

Table 6 (continued).

Level of Education Attained by Parents of Participants in the Adolescent Sample

	Mother's education	Father's education
	n = 22	*n* = 22
Measure	%	%
Education		
… still in school	4.5	
Obligatory school	4.5	
Apprenticeship	50	40.9
Upper professional training	9.1	22.7
High school	4.5	9.1
2 year college	4.5	9.1
University degree	13.6	9.1
....other	9	9

Note. Level of education attained by parents of participants was reported by the adolescent sample.

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Curriculum Vitae

CURRENT POSITION

02/2009 - today	**University of Zurich, Switzerland** Department of Psychology, Applied Psychology: Life-Management, Doctoral student Multimethodological research project on age-related differences in decision making processes
06/2012 - today	Research project: "Decision making across the life span: Do young and older adults differ in information search?" PI: Miriam K. Depping funded by Suzanne und Hans Biäsch Foundation for the Promotion of Applied Psychology

EDUCATION

02/2009 - today	**University of Zurich, Switzerland** Doctoral studies Dissertation: "Decision Making Across the Life Span: The Role of Motivation" Advisor: Alexandra M. Freund
03/2009 - today	**International Max Planck Research School «The Life Course: Evolutionary and Ontogenetic Dynamics»** Fellow & Stipend 06/2011- 09/2012: Fellow-speaker in Zurich 05-06/2011: Research stay at University of Michigan, collaboration with Richard Gonzalez
09/2007 - 06/2008	**University of Toronto, Canada** School of Graduate Studies Diploma thesis project: Investigation of the use of episodic details in planning in young and older adults. Advisor: Morris Moscovitch
09/2006 - 02/2007	**University X Paris, Nanterre, France** Master I Cognitive Psychology ERASMUS exchange program & scholarship

10/2003 - 05/2009	**Humboldt Universität zu Berlin, Germany** Studies of psychology (diploma, GPA 1.5, very good) Major field of study: Cognition and Neuroscience New study and examination regulations (Bologna), Diploma thesis advisors: Morris Moscovitch, Elke Van der Meer

PROFESSIONAL EXPERIENCE

06/2008 - 09/2008	**Charité - Universitätsmedizin Berlin, Campus Benjamin Franklin, Department of Adult Psychiatry, Berlin, Germany** Intern
07/2008 - 01/2009	**eye-square GmbH, Berlin, Germany** Student assistant
11/2005 - 10/2006	**Max Planck Institute for Human Development** Student Assistant in research project on cognitive life-span development (PI: Florian Schmiedek and Martin Lövdén)

AWARDS AND SCHOLARSHIPS

06/2012 - today	**Grant from Suzanne und Hans Biäsch Foundation for the Promotion of Applied Psychology** for research project: "Decision Making across the Life Span: Do young and older adults differ in information search?" (49 967 CHF)
01/2012 - 12/2012	**Grant for Peer-Mentoring Group "Psychophysiology", University of Zurich** Founding member & group-leader together with Simone Schoch (9 980 CHF)
06/2009 - 06/2012	**Scholarship International Max Planck Research School «The Life Course: Evolutionary and Ontogenetic Dynamics», Zurich Site** Funding by Jacobs Foundation
03/2004 - 04/2009	**Scholarship Studienstiftung des Deutschen Volkes** German National Academic Foundation
03/2004 - 04/2009	**Scholarship Evangelisches Studienwerk, Villigst e.V.** German protestant church's scholarship program for gifted students Elected speaker of scholars in Berlin 10/04 -10/05

PUBLICATIONS

Depping, M. K. & Freund, A. M. (2011). Normal Aging and Decision Making: The Role of Motivation. *Human Development, 54,* 349-367.

Napolitano, C. M., Bowers E.P., Gestsdottir, S., Depping , M., von Eye, A., Chase, P., & Lerner, J. V. (2011). The role of parenting and goal selection in positive youth development: A person-centered approach. *Journal of Adolescence, 34,* 1137–1149.

Depping, M. K. & Freund, A. M. (2013). When Choice Matters: Task-dependent Memory Effects in Older Adulthood. Manuscript submitted for publication.

Depping, M.K., & Freund, A.M. (2013) Who is Afraid of Losses? Decision Making in Adolescents, Young, and Older Adults in a Non-Hypothetical, Non-Monetary Gambling Task. Manuscript submitted for publication.

POSTERS AND PRESENTATIONS

Depping, M. K. & Freund, A. M. (2009, May). *Aging and Sensitivity to Gains and Losses in Decision Making.* Poster presented at the LIFE Research School Spring-Academy, Zurich, Switzerland.

Depping, M. K. & Freund, A. M. (2009, August). *Gewinne aufsuchen oder Verluste vermeiden?* Poster presented at the Motivationspsychologisches Kolloquium (MPK), Zurich, Switzerland.

Depping, M. K. & Freund, A. M. (2009, October). *Do Losses Loom Increasingly Larger across Adulthood?.* Poster presented at the LIFE Research School Fall-Academy & the Conference of the Society of Human Development (SSHD), Ann Arbor (MI), USA.

Depping, M. K. & Freund, A. M. (2010, May). *Is Loss Aversion Robust Across Domains and Goal Orientations?.* Poster presented at the LIFE Research School Spring-Academy, Charlottesville, Virginia, USA.

Depping, M. K. & Freund, A. M. (2010, July). *Gains and Losses in Decision-Making in Adolescence and Across Adulthood.* Poster presented at Ph.D. Workshop in Developmental Psychology, Development as action in Context, Dornburg, Germany.

Depping, M. K. & Freund, A. M. (2010, September).*Verluste wirken grösser als Gewinne. Verstärkt sich diese Tendenz über die Lebensspanne?.* Poster presented at the 47. Kongress der Deutschen Gesellschaft für Psychologie, Bremen, Germany.

Depping, M.K. & Freund, A.M. (2011, May). *Age-related changes in the sensitivity to gains and losses in decision making. A non-monetary gambling paradigm.* Presentation at the LIFE Research School Spring-Academy, Ann Arbor (MI), USA.

Depping, M.K. & Freund, A.M. (2011, September). *Positiv-Negativ-Asymmetrien: Die Entscheidung macht's.* Presentation at DGPS Fachgruppentreffen Entwicklungspsychologie, Erfurt, Germany.

Depping, M.K. & Freund, A.M. (2011, November). *An incidental-memory paradigm to investigate age-related differences in the sensitivity to positive and negative information in decision making.* Poster presented at the Society for Judgement and Decision Making annual meeting, Seattle (WA), USA.

Depping, M.K. & Freund, A.M (2011, December). *Age-related differences in the sensitivity to gains and losses in decision making.* Presentation at AWI Workshop on Behavioural Economics and Life-span Changes in Decision Making, Heidelberg, Germany.

Depping, M. K. & Freund, A. M (2012, September). *Emotionale Reaktivität auf Gewinne und Verluste in Entscheidungen: Ein Vergleich von Jugendlichen, jungen und älteren Erwachsenen.* Presentation at 48. Kongress der Deutschen Gesellschaft für Psychologie, Bielefeld,

Germany.

Depping, M. K. & Freund, A. M (2012, November). *Age-related changes in the emotional reactions to gains and losses in decision making*. Presentation at "Doktorandenworkshop Emotionsforschung mit Prof. Dr. Dr. h.c. Klaus R. Scherer", Bonn, Germany.

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Ehrenwort

Hiermit erkläre ich, dass
die Dissertation von mir selbst ohne unerlaubte Beihilfe verfasst worden ist.

_____

Ort und Datum Unterschrift

Erklärung

Hiermit bestätige ich, dass
diese Dissertation noch an keiner anderen Fakultät eingereicht wurde.

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Ort und Datum Unterschrift